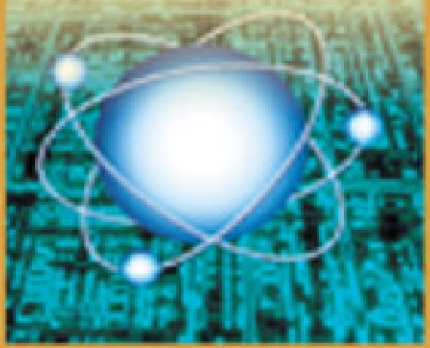
Е.В. Трухан
О.Н. Кобяк

Английский язык

для энергетиков



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Допущено
Министерством образования Республики Беларусь
в качестве учебного пособия для студентов
высших учебных заведений
по энергетическим специальностям

МИНСК
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Р е ц е н з е н т ы: кафедра английского языка экономических специальностей факультета международных отношений Белорусского государственного университета; кандидат педагогических наук доцент кафедры иностранных языков Международного государственного экономического университета имени А.Д. Сахарова *Е.А. Малашенко*

Трухан, Е. В.

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Состоит из пяти тематических разделов о различных видах энергии, как традиционной, так и альтернативной, об основных положениях энергетической науки. Предлагаются тексты с комплексом упражнений на развитие языковых и коммуникативных навыков. Имеются тексты для дополнительного чтения и тематический словарь-минимум.

Для студентов энергетических и других технических специальностей высших учебных заведений, может быть полезно учащимся средних специальных учебных заведений соответствующего профиля, а также специалистам отрасли для деловых контактов на английском языке.

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ПРЕДИСЛОВИЕ

Пособие предназначено для студентов, специализирующихся в области энергетической инженерии и имеющих базовую подготовку по английскому языку: владеют определенным объемом лексических единиц и речевых моделей, знакомы с основными грамматическими категориями. Пособие подготовлено в соответствии с требованиями типовой программы по иностранным языкам для высших учебных заведений.

Целью пособия является совершенствование и систематизация знаний и умений студентов, обогащение их словарного запаса по предлагаемой тематике, формирование навыков понимания, перевода и реферирования текстов по специальности, дальнейшее развитие навыков монологического высказывания на основе письменного текста.

Пособие состоит из пяти разделов. Базой для составления пособия послужили оригинальные тексты. Наряду с текстами в каждом разделе предлагается комплекс упражнений, способствующих активному усвоению лексики, правильному употреблению терминов, повторению некоторых аспектов грамматики, а также позволяющих проверить общее понимание прочитанного. В конце каждого раздела предусмотрены задания на развитие навыков монологической речи с привлечением дополнительных источников информации, что способствует формированию у студентов навыков самостоятельной деятельности и развивает навыки общения с аудиторией и ведения дискуссии на английском языке. Заключительным этапом работы над каждым разделом является обобщающий блок, цель которого – закрепление приобретенных лексических навыков.

Пособие включает тематический раздел для дополнительного чтения и словарь-минимум.

Авторы выражают искреннюю благодарность рецензентам Малашенко Елене Александровне и Маркиной Людмиле Владимировне, чьи замечания позволили улучшить структуру пособия, а также Трухану Матвею Борисовичу за подготовку оригиналов рисунков, Фурсовой Наталье Геннадьевне за содействие в подборе материалов.

Авторы

UNIT I

ENERGY ENGINEERING

Start Here

1. Do you know what forms of energy are of the greatest demand currently? Try to guess the energy sources percent of total energy consumed (see Fig. 1). [12]

1) biomass
2) oil
3) natural gas
4) coal
5) hydropower
6) nuclear
7) other renewable

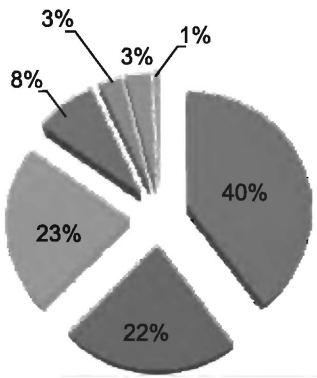

Fig. 1. Diagram of the energy sources percent

2. Read the following international words and mind the stressed syllables.

electricity	transformation	geothermal
electrical	biomass	radioactive
nuclear	chemical	thermal
transform	hydropower	concentration
industrialization	potential	vibration
expertise	kinetic	compression
mechanical	gravitational	technology

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[1] 1) 3%; 2) 40%; 3) 22%; 4) 23%; 5) 3%; 6) 3%; 7) 1%.

3. Match the English and Russian equivalents.

a) biodegradable	1) ископаемое топливо
b) vehicular pollution	2) потреблять энергию
c) transverse waves	3) автотранспортные выбросы
d) fossil fuel	4) способствовать распространению
e) to cause emission	5) поперечные волны
f) ozone depletion	6) совместная выработка
g) co-generation	7) поддающийся разложению
h) to consume energy	8) истощение озонового слоя
i) civil engineering	9) в джоулях
j) in joules	10) гражданское строительство
k) to measure energy	11) британская тепловая единица
l) British thermal unit	12) измерять энергию

4. Match the terms with their definitions.

a) resources	*d) environment*	*g) pollution*
b) energy	*e) molecule*	*h) renewable*
c) consumption	*f) industry*	

1) a source of power;
2) a source of economic wealth, esp. of a country (mineral, land, labour, etc.) or business enterprise (capital, equipment, personnel, etc.);
3) the natural world in which people, animals and plants live;
4) the process of using energy, food or materials;
5) that can be replaced naturally or controlled carefully and can therefore be used without the risk of finishing it all;
6) the production of goods from raw materials, especially in factories;
7) the smallest unit, consisting of a group of atoms, into which a substance can be divided;
8) the process of making air, water, soil, etc. dirty.

Active Vocabulary

5. Give Russian equivalents of the following words and phrases. Try to memorize them.

Nouns and noun phrases

fossil fuel	fuelwood	global warming
biomass	renewable source	ozone depletion
natural gas	coal deposit	consumption

dung cake	power	exploitation
oil, crude oil	hydropower	capacity
solar energy	biodegradable waste	conversion
emission	residue	fuel cell
co-generation	irrigation	vehicular
ability		

Verbs and verbal phrases

to define	to occur	to remain
to heat	to harness	to generate
to derive from	to transform	to exhaust
to reduce	to increase	to combine
to power		

Adjectives

relevant	conventional	geothermal
tidal	nuclear	harmful
available		

Adverbs

per capita	significantly
extremely	tremendously

Reading task: *Text A*

6. Answer the following question and read the text below to check your answer.

What do we need energy for?

What is Energy?

Fig. 2. Sources of energy

Energy lights our cities, powers our vehicles, and runs machinery in factories. It warms and cools our homes, cooks our food, plays our music, and gives us pictures on television.

Energy is defined as the ability or the capacity to do work.

We use energy to do work and make all movements. When we eat, our bodies transform the food into energy to do work. When we run or walk or do some

work, we 'burn' energy in our bodies. Cars, planes, trolleys, boats, and machinery also transform energy into work. Work means moving or lifting something, warming or lighting something. There are many sources of energy that help to run the various machines invented by man.

The discovery of fire by man led to the possibility of burning wood for cooking and heating thereby using energy. For several thousand years human energy demands were met only by renewable energy sources – sun, biomass (wood, leaves, twigs), hydel (water) and wind power.

As early as 4000–3500 BC, the first sailing ships and windmills were developed harnessing wind energy. With the use of hydropower through water mills or irrigation systems, things began to move faster. Fuelwood and dung cakes are even today a major source of energy in rural India. Solar energy is used for drying and heating.

With the advent of the Industrial Revolution, the use of energy in the form of fossil fuels began growing as more and more industries were set up. This occurred in stages, from the exploitation of coal deposits to the exploitation of oil and natural gas fields. It has been only half a century since nuclear power began being used as an energy source.

In the past century, it became evident that the consumption of non-renewable sources of energy had caused more environmental damage than any other human activity. Electricity generated from fossil fuels such as coal and crude oil has led to high concentrations of harmful gases in the atmosphere. This has in turn led to problems such as ozone depletion and global warming. Vehicular pollution is also a grave problem.

There has been an enormous increase in the demand for energy since the middle of the last century as a result of industrial development and population growth. World population grew 3,2 times between 1850 and 1970, per capita use of industrial energy increased about twentyfold, and total world use of industrial and traditional energy forms combined increased more than twelvefold.

Due to the problems associated with the use of fossil fuels, alternative sources of energy have become important and relevant in today's world. These sources, such as the sun and wind, can never be exhausted and are therefore called renewable. Also known as non-conventional sources of energy, they cause less emission and are available locally. Their use can significantly reduce chemical, radioactive, and thermal pollution. They are viable sources of clean and limitless energy. Most of the renewable sources of energy are

fairly non-polluting and considered clean. However, biomass is a major polluter indoors.

Renewable energy sources include the sun, wind, water, agricultural residue, fuelwood, and animal dung. Fossil fuels are non-renewable sources. Energy generated from the sun is known as solar energy. Hydel is the energy derived from water. Biomass – firewood, animal dung, and biodegradable waste from cities and crop residues – is a source of energy when it is burnt. Geothermal energy is derived from hot dry rocks, magma, hot water springs, natural geysers, etc. Ocean thermal is energy derived from waves and also from tidal waves.

Through the method of co-generation a cleaner and less polluting form of energy is being generated. Fuel cells are also being used as cleaner energy source.

Total commercial energy consumption has been growing tremendously since the last decade. Per capita commercial energy consumption in low-income countries have more than doubled. About 15% of the world's population living in the wealthy industrialized nations consume over half the energy used in the world. The number of motor vehicles in use worldwide has more than doubled since 1970.

In some respects, the global energy system has evolved in a cleaner direction in the last 25 years. The share of world primary energy derived from natural gas – the cleanest fossil fuel – has increased by more than 25%. So has the use and generation of renewable energy sources.

Still, the overall efficiency of energy production remains extremely low: on average, more than 90% of energy consumed is lost or wasted in the process of conversion from raw materials such as coal to the final energy service such as the light to read a book. The main problem isn't that we use energy, but how we produce and consume energy resources. What we really need are energy sources that will last forever and can be used without polluting the environment. Conserving energy has become the need of the day be it in the transport, household, or industrial sectors. [10]

Comprehension Check

7. Decide whether the following statements are true or false according to the text.

1) The discovery of fire by man was the first step to use energy.
2) The very first energy sources were renewable.

3) The use of wind energy influenced the speed of moving.
4) Hydropower is a major source of energy in some countries.
5) Nuclear power has been used as an energy source for a century.
6) Vehicular pollution is considered to be a serious problem.
7) Industrial development and population growth results in increasing demand for energy.
8) The sun, wind, water are non-renewable sources.
9) Hydropower is energy derived from waves.
10) The use and generation of renewable energy sources have increased by more than 25%.

8. Complete the following sentences according to the text.

1) Energy is defined as … .
2) Work means … .
3) The consumption of non-renewable sources of energy causes … .
4) Such sources as the sun and wind, can never be exhausted and are therefore called … .
5) Renewable energy sources include … .
6) 15% of the world's population in developed countries consume … .

9. Answer the following questions and give examples.

1) Why do we need energy?
2) When did people begin to use wind energy? Give the reason.
3) When did the use of energy in the form of fossil fuels begin growing? Why?
4) Why have alternative sources of energy become important and relevant in today's world?
5) What are non-conventional energy sources?
6) Where is geothermal energy derived from?
7) What method was used to generate a cleaner and less polluting form of energy?
8) What sources do we call non-renewable? Why?
9) What is the main problem we deal with nowadays?

10. What parts of the text can you define? Do they correspond to the paragraphs? Name each part.

1. _____ 4. _____
2. _____ 5. _____
3. _____ … _____

11. Write a summary of Text A[1].

Language Focus

12. Match the synonyms.

1) to define	a) need
2) to transform	b) harm
3) various	c) very
4) demand	d) to use
5) to harness	e) obvious
6) evident	f) exhaustion
7) to generate	g) to determine
8) damage	h) different
9) depletion	i) to change
10) extremely	j) to produce

13. Fill in the correct prepositions, then choose any five items and make up sentences of your own.

1) to transform sth ... sth; 2) due ... the problem; 3) to be ... turn; 4) ... some respects; 5) to increase ... demand; 6) to increase ... 25%; 7) the demand ... energy; 8) ... average; 9) a result ... development; 10) need ... the day.

14. Form the nouns from the following verbs using suffixes *-tion*, *-ment*, *-y*.

to transform →...	to convert →...
to exploit →...	to define →...
to consume →...	to pollute →...
to generate →...	to industrialize →...
to emit →...	to develop →...
to discover →...	to increase →...
to move →...	to concentrate →...

15. Translate the following text into English using the vocabulary of the text.

Энергия – это способность выполнять работу. Энергия может находиться в людях и животных, в камнях и растениях, в ископаемом топливе, в деревьях и воздухе, в реках и озерах. В нашем индустриальном обществе от энергии зависит все. С ее помощью можно обогреть жилище и привести в действие кондиционеры, осветить улицы. Мир наполнен энергией, кото-

[1]**Summary** – a short statement (in 150 words) that gives only the main points of something, not the details. [5]

рая может быть использована для совершения работы разного характера. Однако самыми большими резервуарами накопленной энергии являются океаны – огромные массы беспрерывно перемещающихся водных потоков, покрывающих около 71% всей земной поверхности.

Over to you

16. Discuss with your groupmates or in pairs:

1) link between Industrial Revolution and use of energy;
2) link between population growth and energy consumption.

Active Vocabulary

17. Give Russian equivalents of the following words and phrases. Try to memorize them.

Nouns and noun phrases

substance	tension	nucleus
fission	cell phone	motion
fusion	reservoir	petroleum
fireplace	particle	rarefaction
object	dam	wire

Verbs and verbal phrases

to compress	to include	to convert
to store	to collide	to transfer
to split	to release	to charge

Adjectives

stretched	transverse	dramatic
tiny	longitudinal	radiant

Reading Task: *Text B*

18. Answer the following question and read the text below to check your answer.

What forms of energy do you remember from the course of Physics?

Forms of Energy

Energy is found in different forms including light, heat, chemical, and motion. There are many forms of energy, but they can all be put into two categories: potential and kinetic.

Kinetic energy is motion – of waves, molecules, substances, and objects. Forms of kinetic energy include:

- Radiant Energy is electromagnetic energy that travels in transverse waves. Radiant energy includes visible light, x-rays, gamma rays and radio waves. Light is one type of radiant energy. Sunshine is radiant energy, which provides the fuel and warmth that make life on the Earth possible.
- Thermal Energy, or heat, is the vibration and movement of the atoms and molecules within substances. As an object is heated up, its atoms and molecules move and collide faster. Geothermal energy is the thermal energy in the Earth.
- Motion Energy is energy stored in the movement of objects. The faster they move, the more energy is stored. It takes energy to get an object moving and energy is released when an object slows down. Wind is an example of motion energy. A **dramatic** example of motion is a car crash, when the car comes to a total stop and releases all its motion energy at once in an uncontrolled instant.
- Sound is the movement of energy through substances in longitudinal (compression/rarefaction) waves. Sound is produced when a force causes an object or substance to vibrate – the energy is transferred through the substance in a wave. Typically, the energy in sound is far less than other forms of energy.

Potential energy is stored energy and the energy of position – gravitational energy. There are several forms of potential energy:

- Chemical Energy is energy stored in the bonds of atoms and molecules. Biomass, petroleum, natural gas, and coal are examples of stored chemical energy. Chemical energy is converted to thermal energy when we burn wood in a fireplace or burn gasoline in a car's engine.
- Mechanical Energy is energy stored in objects by tension. Compressed springs and stretched rubber bands are examples of stored mechanical energy.
- Nuclear Energy is energy stored in the nucleus of an atom – the energy that holds the nucleus together. Very large amounts of energy can be **released** when the nuclei are combined or split apart. Nuclear power plants split the nuclei of uranium atoms in a process called fission. The sun combines the nuclei of hydrogen atoms in a process called fusion.
- Gravitational Energy is energy stored in an **object's** height. The higher and heavier the object, the more gravitational energy is stored. When you ride a bicycle down a steep hill and **pick up**

speed, the gravitational energy is being converted to motion energy. Hydropower is another example of gravitational energy, where the dam **«piles» up** water from a river into a reservoir.

• Electrical Energy is what is stored in a battery, and can be used to power a cell phone or start a car. Electrical energy is delivered by tiny charged particles called electrons, typically moving through a wire. Lightning is an example of electrical energy in nature, so powerful that it is not confined to a wire. [7]

Comprehension Check

19. Complete the following sentences according to the text.

1) Energy is found in different forms including …
2) All forms of energy can be put into two categories: … and …
3) Kinetic energy is …
4) … are forms of kinetic energy.
5) Sunshine provides …
6) Geothermal energy is …
7) The faster objects move, the more energy is ...
8) The energy in sound is far less than …
9) Potential energy is stored energy and …
10) Forms of potential energy include …
11) Chemical energy is converted to thermal energy when we …
12) Nuclear power plants split the nuclei of uranium atoms in a process called … . But the sun combines the nuclei of hydrogen atoms in a process called ...
13) The … the object, the more gravitational energy is stored.
14) Electrical energy is delivered by … called electrons.

20. Answer the following questions and give examples.

1) What are the main categories of energy?
2) What is potential energy?
3) What is kinetic energy?
4) When is chemical energy converted to thermal energy?
5) Fission and fusion are synonyms, aren't they? Why? Why not?
6) What physical process happens when you ride a bicycle?
7) What is named «an electron»?
8) What makes life on the Earth possible?

9) As an object is heated up, its atoms and molecules move and collide slower, don't they? Why? Why not?
10) What is the least form of energy?

21. Fill in the table using the information from Text B.

Energy categories	Forms of energy	Definitions	Examples
kinetic energy	radiant energy	…	visible light, x-rays, gamma rays, radio waves
	thermal energy	…	…
	…	is stored in the movement of objects	…
	…	…	…
…	chemical energy	…	biomass, coal, petroleum, natural gas
	…	is stored in objects by tension	…
	…	…	…
	…	…	hydropower, …
	electrical energy	…	…

22. Choose the best abstract[1] for Text B.

a) The text under consideration is about energy. It dwells on the usage and examples of different energy forms in nature.
b) The text deals with two categories of energy such as potential and kinetic. The author gives the definitions of various forms of energy and points out their examples.
c) The examples of several energy forms are commented in the text. The author also touches upon the difference between kinetic and potential energies.

[1] **Abstract** – a condensed version of a piece of writing, speech, etc. [5]

23. Find key words and phrases which best express the general meaning of each paragraph.

24. Write a summary of Text B. Consult page 10.

Language Focus

25. Choose the contextual meanings of the words written in bold in Text B.

1. **dramatic**
   a) резкий
   b) яркий
   c) драматичный
   d) существенный
2. **to release**
   a) пускать
   b) высвобождать
   c) избавлять
   d) разъединять
3. **object**
   a) объект
   b) предмет
   c) цель
   d) вещь
4. **to pick up**
   a) забирать
   b) набирать
   c) подбирать
   d) поднимать
5. **to pile up**
   a) скапливать
   b) громоздить
   c) наращивать
   d) разбить

26. Combine the words from the column on the left with the suitable nouns from the column on the right. Translate them into Russian.

1) compressed	a) instant
2) tiny	b) waves
3) transverse	c) springs
4) visible	d) light
5) total	e) particles
6) uncontrolled	f) stop

27. Fill in the correct prepositions, translate the phrases, then choose any three items and make up sentences of your own.

1) to put … two categories; 2) to store … sth. … tension; 3) the examples … sth.; 4) to convert … sth.; 5) to burn gasoline … a car's engine; 6) to ride a bicycle … a steep hill; 7) to make life … the

Earth possible; 8) movement … sth. … substances; 9) … once; 10) to deliver … charged particles; 11) to transfer … the substance.

Over to you

28. Discuss with your groupmates or in pairs the examples of potential and kinetic forms of energy from everyday life.

Active Vocabulary

29. Give Russian equivalents of the following words and phrases. Try to memorize them.

Nouns and noun phrases

engineering	range	principle
environment	option	technology
branch	device	structure
installation	quality	expertise
qualification	modification	advance
service	households	equipment
ecosystem	research department	forefront

Verbs and verbal phrases

to cover	to design	to maintain
to link with	to ensure	to conduct
to influence	to consider	to achieve
to rely on	to preserve	to depend on
to construct	to repair	to recognize
to involve	to focus on	to manufacture
to be concerned with		

Adjectives	**Adverb**	**Preposition**
senior	ultimately	prior to
innovative		
extensive		

Reading Task: *Text C*

30. The following text is in the jumbled order. Look at the plan of the text, read the paragraphs and number them in the correct order according to the plan.

Energy Engineering

Plan:

1) What does an engineer do?
2) Some examples of jobs that engineers do.
3) Environmental engineer.
4) Renewable energy engineer.
5) Sounds interesting, so how do I get into it?

□ Firstly, you need to consider whether you enjoy science and mathematics subjects, because many engineering and technology roles are based on science and mathematics principles. Depending on what kind of job you would like, you will probably need qualifications in these subjects. Qualifications in ICT and design and technology (D&T) are also extremely useful.

It may also be helpful to know that there are three nationally (and internationally) recognized professional levels that you can work towards. Each of these levels can be achieved by various routes of study – going to university to study an engineering course is just one of the many options available to you.

□ The word 'engineering' is likely to make you think of things like shipbuilding, 'engineering works' on the railway lines, or perhaps the mechanic that services or repairs your washing machine or car. In reality, engineering covers a far wider range of businesses and industries; not only building and transport structures, but also jobs in food, cosmetics, medicine and much more. Engineers work in all kinds of environments. There are still many jobs in traditional engineering sectors, but engineers are just as likely to work in offices, laboratories or studios, or outdoors, in the air and underground. Engineering today is closely linked with technology and many engineering roles now rely heavily on technological devices and the most recent technological advances.

□ The quality of the land, air and water around us is becoming increasingly important with the onset of climate change. Engineers are at the forefront of preserving our planet and ensuring that modern technology is kind to the world in which we live. Being an environmental engineer might mean that you have a special interest in ecosystems and biology, or other branches of engineering like civil engineering (buildings, roads and structures). People who deal in public health matters may also be environmental engineers, helping to ensure that our world is preserved for humans as well as for plants and animals.

□ Engineers are concerned with the production of energy through natural resources such as the sourcing and use of wind, solar and wave power. They are involved in developing and maintaining power stations and the machinery used in alternative energy sourcing and production e.g. biofuel sourced from crops. Energy engineers construct equipment designed by engineering designers, and conduct testing and make modifications prior to installation and running. This involves extensive use of computer technology. They may work for industry, university or government research departments. They may hold senior positions, head up a team of energy engineers or have a key post in the team. Ultimately these engineers are focused on finding efficient, clean and innovative ways to supply energy to millions of households for years to come. Renewable energy is extremely important to the future of our planet and that's something that we'd all like to rely on.

□ Engineers influence every aspect of modern life and it's likely that today you will have already relied on the expertise of one or more engineers. Perhaps you've listened to an iPod? Or watched television? Did you wash your hair today? Do you use a bus on your way to the University? These have all been designed, developed and manufactured by engineers. Here are some examples of where engineers work to get you started. [14]

Comprehension Check

31. Answer the following questions and give examples.

1) Where do engineers work?
2) Do engineers influence every aspect of life?
3) Environmental engineers have a special interest in ecosystems and biology, don't they? Why? Why not?
4) What are renewable energy engineers concerned with?
5) What are they involved in?
6) What do energy engineers construct?
7) Is computer technology extensively used in the engineers' work? Give examples.
8) What are energy engineers focused on?
9) What principles are engineering and technology roles based on?
10) What are the three recognized professional levels?

32. Find key words and phrases which best express the general meaning of each paragraph.

33. Write a summary of Text C. Consult page 10.

Language Focus

34. Choose the correct word.

As an engineer involved in energy **production / manufacture**, you work on the extraction of **oil / petroleum** and gas, or on producing energy from **renewable / non-renewable** or sustainable sources such as wind power, solar power or biofuels.

You **might / must** work in a **wide / narrow** variety of energy production roles, for example:

- as a reservoir engineer, calculating how much oil or gas a **well / source** will produce and planning how to extract as **much / little** as possible
- researching new ways of **generating / converting** energy
- designing **machinery / devices** and developing ways of improving existing processes
- overseeing the drilling **operations / acts** on an offshore rig.

Your day-to-day tasks **depend / focus** on the type of project you are involved in, but might **include / achieve**:

- using mathematical and computer **models / principles** to calculate the size and shape of a reservoir
- deciding on the best locations for production wells to **maximize / minimize** profit
- co-ordinating the **work / job** of a drilling team
- designing and selecting **equipment / structure**
- making sure oil or gas extraction meets environmental **standards / qualifications**
- analysing drilling performance and factors **affecting / modifying** cost and efficiency
- working with other professionals such **as / so** geologists, geophysicists and specialist contractors
- carrying out laboratory **experiments / researches** and converting them into **large-scale / small-scale** industrial processes.

Over to you

35. Discuss with your groupmates or in pairs the job of a renewable energy engineer. You may use the keys below.

Keys:

- The work of a renewable energy engineer is concerned with …
- They are involved in …

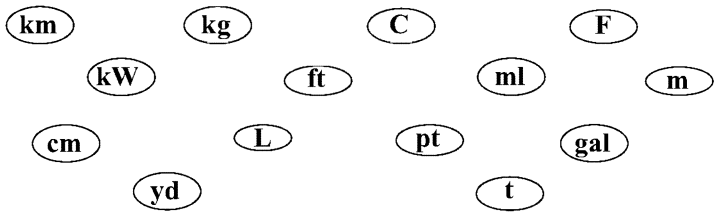
- They also construct … and conduct …
- An energy engineer may work for …
- Ultimately an engineer is focused on …

Language Development

36. Match technical fields with appropriate examples of products.

Technical field	Products
1) marine engineering	a) the road surface of a bridge
2) transport engineering	b) flat surface of a skateboard
3) building and construction	c) cement area around a swimming pool
4) civil engineering	d) computer game console
5) sports technology	e) flight deck
6) aerospace	f) a floor of a ship
7) electronics	g) a level of a bus
8) IT, entertainment industry	h) component of music system

37. What do the following mean? Are these abbreviations of metric or non-metric measures?



Example: km = kilometre (metric)

It's important to know

38. Read the following text and fill in the words from the list below.

a) energy	*d) lived*	*g) after*
b) amount	*e) coffee*	*h) system*
c) joules	*f) alled*	

How Energy is Measured

One of the basic measuring blocks for energy is 1) _____ a Btu or British thermal unit. Btu is defined as the amount of heat energy it takes to raise the temperature of 1 pound of water by 1 degree Fahrenheit, at sea level. One Btu equals about one black-tip kitchen match. It takes about 2000 Btu to make a pot of 2) _____.

Energy can also be measured in 3) _____ (pronounced the same way as ' jewels'). One joule is the 4) _____ of energy needed to lift 1 pound about 9 inches. It takes 1000 joules to equal a Btu. It would take 2 million joules to make a pot of coffee.

Joule is named 5) _____ an English physicist James Prescott Joule who 6) _____ from 1818 to 1889. He discovered that heat is a type of 7) _____.

Around the world, scientists measure energy in joules rather than Btu. It is much like people around the world using the metric 8) _____, metres and kilograms. Like in the metric system, you can have kilojoules: 'kilo' means 1000, therefore, 1000 joules = 1 kilojoule = 1 Btu. [1]

Follow Up

39. Read the texts of Unit I again and make notes under the following headings. Then use your notes to talk about *Energy* and *Energy Engineering*.

1) The definition of energy.
2) Sources of energy.
3) Potential and kinetic energies.
4) The work of an energy engineer.

Check Your Knowledge

1. Choose the best option.

1) There are two forms of energy: …
   a) electrical and mechanical
   b) chemical and thermal
   c) kinetic and potential
2) Oil and natural gas are …
   a) renewable
   b) non-renewable
   c) non-conventional
3) The cleanest fossil fuel is …
   a) oil
   b) natural gas
   c) coal
4) Energy of position is … energy
   a) gravitational
   b) mechanical
   c) motion
5) Large amounts of energy can be released when the nuclei are …
   a) combined
   b) split apart
   c) combined or split apart
6) Sound is the movement of energy …
   a) over an object
   b) through substances
   c) in an object or substance
7) Renewable energy engineers …
   a) help to ensure that our world is preserved for humans
   b) are focused on finding clean, innovative ways to supply energy
   c) work in building and transport structures

2. Fill in the gaps.

1) The _____ is responsible for every _____ in the factory. (*engineering / engineer / engine*)

2) The lab _____ repairs all the _____ equipment on the rig. (*technician / technological / technology*)
3) The _____ repairs all the _____ equipment on the rig. (*electrician / electrical / electricity*)
4) _____ power plants split the _____ of uranium atoms in a process called fission. (*nuclear / nucleus / nuclei*)
5) 90% of energy _____ is lost that's why the main problem is how we produce and _____ energy resources. (*consumption / consume / consumed*)

3. Translate these phrases into English.

Возобновляемые источники энергии; природные ископаемые; вред окружающей среде; потребление энергии солнца; промышленное развитие; ветряные мельницы; лучистая энергия; движение молекул; атомы водорода; влиять на все сферы современной жизни; технические устройства; метрическая система; исследование месторождения нефти; увеличение потребности; загрязнение транспортными средствами; залежи угля; в среднем; гражданское строительство; исследовательский отдел.

4. Write these numbers and units in abbreviations. Fill in the table below according to what they measure.

1) 5 kilometres – …
2) 250 kilograms – …
3) 0° Celsius – …
4) 10 miles – …
5) 40 litres – …
6) 500 feet – …
7) 12 tonnes – …
8) 15 metres – …
9) 160° Fahrenheit – …
10) 3 gallons – …

Length	Weight	Capacity	Temperature

UNIT II

TRADITIONAL SOURCES OF ENERGY

Start here

1. Read the following international words and mind the stressed syllables.

boiler	factor	material
occasionally	energy	industrial
engine	civilization	revolution
eurbines	construct	compact
generate	permanent	effective
popularity	structure	distance

2. Match the English and Russian equivalents.

a) flammability	1) домашний очаг
b) boiling point	2) бетонная промышленность
c) byproduct	3) сжиженный природный газ
d) heart	4) точка кипения
e) rural area	5) побочный продукт
f) conveyer belt	6) воспламеняемость
g) concrete industry	7) сельская местность
h) liquefied natural gas	8) транспортерная лента
i) coal reserves	9) теплотворная способность
j) heating value	10) запасы угля

3. Match the terms with their definitions.

a) petroleum	*d) natural gas*	*g) charcoal*
b) the draft	*e) boiler*	*h) sustainable*
c) barrel	*f) mining*	*i) stove*

1) the amount of air allowed to reach the fire;
2) rock oil or oil from the Eearth;
3) a household device providing a hot-water supply or serving a central heating system;
4) an apparatus for cooking and heating that operates by burning fuel or using electricity;
5) a black amorphous form of carbon made by heating wood or other organic matter in the absence of air: used as a fuel, in smelting metal ores, in explosives, and as an absorbent;

6) capable of being maintained at a steady level without exhausting natural resources or causing severe ecological damage;
7) the act, process, or industry of extracting coal, ores, etc., from the Earth;
8) a unit of capacity used in the oil and other industries, normally equal to 42 US gallons or 35 Imperial gallons;
9) flammable gas, consisting largely of methane and other hydrocarbons, occurring naturally underground (often in association with petroleum) and used as fuel.

Active Vocabulary

4. Give Russian equivalents of the following words and phrases. Try to memorize them.

Nouns and noun phrases

charcoal	campfire	exhaustion
sawdust	stove	masonry heater
quantity	bonfire	thermal mass
application	convection	draft
furnace	hearth	ash
soapstone	heat exchanger	causticity
combustion	purpose	tile

Verbs and verbal phrases

to disintegrate	to resemble	to escape

Adjectives

concurrent	portable	refractory
incomplete	freestanding	

Reading Task: *Text A*

5. Answer the following questions and read the text below to check your answers.

1) What do you think was the very first source of energy for people?
2) How long have people been using wood as a fuel?

Wood Fuel

Wood fuel is wood used as fuel. The burning of wood is currently the largest use ofenergy derived from a solid fuel biomass. Wood fuel can be used for cooking and heating, and occasionally for fueling steam engines and steam turbines that generate electricity. Wood fuel may be available as firewood (e.g. logs, blocks), charcoal, chips, sheets, and sawdust. The **particular** form used depends upon factors such as source, quantity, quality and application. Wood may be sent into a furnace to be burned, stove, fireplace, or in a campfire, or used for a bonfire. Wood is the most easily available form of fuel, and it is a renewable source of energy.

The use of wood as a fuel source for heating is as old as civilization itself.

Early **examples** include the use of wood heat in tents. Fires were constructed on the ground, and a smoke hole in the top of the tent allowed the smoke to escape by convection.

In permanent structures and in caves, hearths were constructed – surfaces of stone or another noncombustible material upon which a fire could be built. Smoke escaped through a smoke hole in the roof.

The Greeks, Romans, Celts, Britons, and Gauls all had access to forests suitable for using as fuel.

Total demand for fuel increased considerably with the industrial revolution but most of this increased demand was met by the new fuel source. Coal, which was more compact and more suited to the larger scale of the new industries.

The development of the chimney and the fireplace allowed for more effective exhaustion of the smoke. Masonry heaters or stoves went a step further by capturing much of the heat of the fire and exhaust in a large thermal mass, becoming much more efficient than a fireplace alone.

The metal stove was a technological development concurrent with the industrial revolution. Stoves were manufactured or constructed pieces of equipment that contained the fire on all sides and provided a means for controlling the draft. Stoves have been made of a variety of materials: cast iron, soapstone, tile, and steel. Metal stoves are often lined with refractory materials such as firebrick, since the hottest part of a woodburning fire will burn away steel over the course of several years' use.

The Franklin stove was developed in the United States by Benjamin Franklin. More a manufactured fireplace than a stove, it had an open front and a heat exchanger in the back that was **designed** to draw air from the cellar and heat it before releasing it out the sides. So-called «Franklin» stoves today are made in a great variety of styles, though none resembles the original design.

The 1800s became the high point of the cast iron stove. Each local foundry would make their own design, and stoves were built for myriads of purposes – parlour stoves, camp stoves, railroad stoves, portable stoves, cooking stoves and so on. Wood or coal could be burnt in the stoves and thus they were popular for over one hundred years. *The action of the fire, combined with the causticity of the ash, ensured that the stove would eventually disintegrate or crack over time. Thus a steady supply of stoves was needed. The* ***maintenance*** *of stoves, needing to be blacked, their smokiness, and the need to split wood meant that oil or electric heat found favour.*

In the 19th century the airtight stove, originally made of steel, became common. They allowed greater control of combustion, being more tightly fitted than other stoves of the day.

Use of wood heat declined in popularity with the growing availability of other, less labor-intensive fuels. Wood heat was gradually replaced by coal and later by fiel oil, natural gas and propane heating except in rural areas with available forests.

Today in rural, forested parts of the U.S., freestanding boilersare increasingly common. They are installed outdoors, some distance from the house, and connected to a heat exchanger in the house using underground piping. The mess of wood, bark, smoke, and ashes is kept outside and the risk of fire is reduced. The boilers are large enough to hold a fire all night, and can burn larger pieces of wood, so that less cutting and splitting is required. However, outdoor wood boilers emit more wood smoke and associated pollutants than other wood-burning appliances. This is due to design **characteristics** such as the water-filled jacket surrounding the firebox, which acts to cool the fire and leads to incomplete combustion. An alternative that is increasing in popularity are wood gasification boilers, which burn wood at very high efficiencies (85–91%) and can be placed indoors or in an outbuilding.

As a sustainable energy source, wood fuel is still used today for cooking in many places, either in a stove or an open fire, in many industrial processes, including smoking meat and making maple syrup, it also remains viable for generating electricity in areas with easy access to forest products and by-products. [8]

Comprehension Check

6. Decide whether the following statements are true or false according to the text.

1) Wood fuel can be used for cooking and heating, but can not be used for fueling steam engines.

2) Early examples include the use of wood heat near tents.
3) Total demand for fuel increased considerably with the industrial revolution.
4) This increased demand was met by the new fuel source, Oil.
5) Stoves have been made of metal materials only.
6) «Franklin» stoves aren't made today.
7) Wood gasification boilers can be placed indoors or in an outbuilding.
8) Wood fuel remains viable in areas with easy access to forest.

7. Put the following sentences in the correct order according to the text.

1) ___ The Greeks, Romans, Celts, Britons, and Gauls all had access to forests suitable for using as fuel.
2) ___ Today in rural, forested parts of the U.S., freestanding boilers are increasingly common.
3) ___ So-called «Franklin» stoves today are made in a great variety of styles.
4) ___ Masonry heaters or stoves went a step further becoming much more efficient than a fireplace alone.
5) ___ The 1800s became the high point of the cast iron stove.
6) ___ The metal stove was a technological development concurrent with the industrial revolution.
7) ___ In the 19th century the airtight stove, originally made of steel, became common.
8) ___ Most of total demand for fuel was met by the new fuel source, coal.

8. Answer the following questions.

1) What is wood fuel?
2) What can wood fuel be used for?
3) What does the particular form of wood fuel used depend upon?
4) Is wood a renewable or non-renewable source of energy?
5) What is the earliest example of the use of wood as a fuel source?
6) What allowed more effective exhaustion of the smoke?
7) What materials have stoves been made of?
8) Where was the Franklin stove developed? What is its characteristic?
9) What were stoves built in the 1800s for?
10) What type of stoves became popular in the 19th century?
11) Why did the use of wood heat decline in popularity?
12) Is it still used today? Where?

9. Translate the italicized passage (see page 27) in written form paying attention to the Participles.

10. Divide the text into logical parts and make an oral report on the text according to the plan below.

Plan:

1. **The Title**

I've read the text (article, story) entitled...
I'd like to tell you about the text (article, story) entitled ...

2. **The Source**

This is an article (story, text) published in the newspaper (magazine, book) ...

3. **The Author**

The author of the text is ..., a famous writer (journalist, scientist).

4. **The Idea**

The main idea of the text (article, story) is to show (to prove, to underline, to convince)...

5. **The Subject**

The text deals with ...
The text describes (gives information about)...

6. **The Content**

The text (story, article) starts with the fact (with the description of, with the characteristic of)...
Then the author describes ...
After that the author touches upon the problem of ...
Next the author deals with the fact (the problem)...
Besides the author stresses that ...
Finally the author comes to the conclusion that...

7. **Your Attitude**

My attitude to the article (story, text) is contradictory (complicated, simple).
On the one hand I agree that...
On the other hand I can't agree that ...
I've learned a lot of interesting (important, new) facts (information, things) from the text.
It makes us think of...
It gives us food for thoughts.
It proves the idea (the theory, the point of view, the opinion) ...

It can help us in self-education (in solving our problems).
I'd like to cite the author (to make a quotation).

8. **Your Advice**

So in my opinion it is (not) worth reading…

Over to you

11. Discuss with your groupmates or in pairs why coal and wood are considered to be traditional sources of energy.

Language Focus

12. Choose the contextual meanings of the words written in bold in Text A.

1. **particular**
   a) редкий
   b) личный
   c) особый
   d) частный
2. **example**
   a) пример
   b) иллюстрация
   c) образец
   d) экземпляр
3. **to design**
   a) планировать
   b) предназначать
   c) конструировать
   d) проектировать
4. **maintenance**
   a) содержание
   b) сохранение
   c) поддержка
   d) эксплуатация
5. **characteristic**
   a) особенность
   b) качество
   c) признак
   d) свойство

13. Match the opposites.

1) permanent	a) unusual
2) to construct	b) to separate
3) to increase	c) to raise
4) to release	d) to draw in
5) popular	e) urban
6) to combine	f) to destroy
7) common	g) temporary
8) rural	h) unknown
9) to reduce	i) to decrease

14. Form the verbs from the following nouns.

application →...	development →...	equipment →...
construction →...	exhaustion →...	variety →...
convection →...	heater →...	maintenance →...

15. Unjumble the words.

Model: veots → stove

1) sabsmoi →...	4) noitailizciv →...	7) yrstduni →...
2) ebnirtu →...	5) traehh →...	8) eboril →...
3) yticirtleec →...	6) ecplaerif →...	9) eyihcnm →...

16. Translate the following words and phrases into English using the vocabulary of the text.

Вырабатывать электричество, капитальные сооружения, общий объем спроса, негорючий материал, промышленная революция, эффективное вытягивание, кирпичная печь, техническое развитие, способ управления тягой, огнеупорный материал, промышленная топка, разнообразные цели, заслужили благосклонность, герметическая печь, трудоемкое горючее, автономный котел (бойлер), теплообменник, водоналивная облицовка, экологически устойчивый источник энергии.

It's important to know

17. Read the text translating the words in brackets and answer the questions below the text.

Energy Content

A common *(древесина твердых пород)*, red oak, has an energy content of 14,89 megajoules per kilpgram (6,388 BTU per pound), and 10,423 megajoules recoverable if burned at 70% *(эффективность)*.

The Sustainable Energy Development Office (SEDO), part of the Government of Western Australia *(утверждает)* that the energy content of wood is 16,2 megajoules per kilogram (4,5 kWh/kg).

According to *The Bioenergy Knowledge Centre*, the energy content of wood is much more dependent on the moisture *(содержание)* than the species. The *(энергетический)* content (number of joules of *(тепло)* produced) improves towards the total number of joules stored in the wood as it dries. [10]

1) What is the energy content of a common hardwood?
2) What is the energy content of wood according to SEDO?
3) What is the energy content of wood dependent on according to The Bioenergy Knowledge Centre?

Active Vocabulary

18. Give Russian equivalents of the following words and phrases. Try to memorize them.

Nouns and noun phrases

sedimentary rock	carbon	pressure
dead plants	hydrocarbon	remains
top layer	content	ethylene
coke	anthracite	depth
sulfur	lignite	heating value
methanol	tar	raw material
deposit	moisture	surface mining
steam	flexibility	underground mining
synthetic fibers	reserves	conveyer belt
preparation plant	iron ore	power plant

Verbs and verbal phrases

to trap	to create	to sink
to compose of	to contain	to account
to mine	to be subjected to	to process
to ship	to bake	to smelt

Adjectives

swampy	bituminous	abundant
crumbly	subbituminous	expensive

Reading Task: *Text B*

19. Answer the following question and read the text below to check your answer.

1) Is coal a renewable source of energy?
2) What are the main ranks of coal?

Coal

Coal is a combustible black or brownish-black sedimentary rock composed mostly of carbon and hydrocarbons. Coal is a non-renewable energy source because it takes millions of years to create. The energy in coal comes from the energy stored by plants that lived hundreds of millions of years ago, when the Earth was partly covered with swampy forests.

For millions of years, a layer of dead plants at the bottom of the swamps was covered by layers of water and dirt, trapping the energy of the dead plants. The heat and pressure from the top layers helped the plant remains turn into what we today call coal (see Fig. 3).

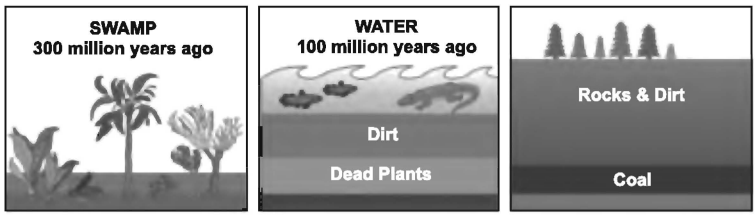


Fig. 3. How coal was formed.

Coal is classified into four main types, or ranks (anthracite, bituminous, subbituminous, and lignite), depending on the amounts and types of carbon it contains and on the amount of heat energy it can produce. The rank of a deposit of coal depends on the pressure and heat acting on the plant debris as it sank deeper and deeper over millions of years.

- **Anthracite** contains 86–97% carbon, and generally has a heating value slightly higher than bituminous coal. It accounts for less than 0,5% of the coal mined in the United States.
- **Bituminous coal** contains 45–86% carbon. Bituminous coal was formed under high heat and pressure. Bituminous coal in the United States is between 100 to 300 million years old. It is the most abundant rank of coal found in the United States. Bituminous coal is used to generate electricity and is an important fuel and raw material for the steel and iron industries.
- **Subbituminous** coal has a lower heating value than bituminous coal. It typically contains 35–45% carbon. Most subbituminous coal in the United States is at least 100 million years old. About 46% of the coal produced in the United States is subbituminous.

• **Lignite** is the lowest rank of coal with the lowest energy content. Lignite coal deposits tend to be relatively young coal deposits that were not subjected to extreme heat or pressure, containing 25–35% carbon. It is crumbly and has high moisture content.

Coal miners use giant machines to remove coal from the ground. They use two methods: surface or underground mining. Modern mining methods allow us to easily reach most of our coal reserves.

Surface mining is used to produce most of the coal in the US because it is less expensive than underground mining. Surface mining can be used when the coal is buried less than 200 feet underground.

Underground mining, sometimes called deep mining, is used when the coal is buried several hundred feet below the surface. Some underground mines are 1,000 feet deep.

After coal comes out of the ground, it typically goes on a conveyor belt to a preparation plant that is located at the mining site. The plant cleans and processes coal to remove other rocks and dirt, ash, sulfur, and unwanted materials, increasing the heating value of the coal.

After coal is mined and processed, it is ready to be shipped to market.

Coal is used to create almost half of all electricity generated in the US. Power plants burn coal to make steam. The steam turns turbines that generate electricity.

A variety of industries use coal's heat and by-products. Separated ingredients of coal (such as methanol and ethylene) are used in making plastics, tar, synthetic fibers, fertilizers, and medicines.

Coal is also used to make steel. Coal is baked in hot furnaces to make coke, which is used to smelt iron ore into iron needed for making steel. It is the very high temperatures created from the use of coke that gives steel the strength and flexibility for things like bridges, buildings, and automobiles. The concrete and paper industries also use large amounts of coal. [8]

Comprehension Check

20. Finish the following sentences according to the text.

1) Coal is composed of …
2) The energy in coal comes from the energy …
3) A layer of dead plants was covered by …

4) The rank of a deposit of coal depends on ...
5) Bituminous coal contains ...
6) ... is the lowest rank of coal with the lowest energy content.
7) Lignite coal deposits were not subjected to ...
8) Coal miners use giant machines ...
9) Surface mining can be used when the coal is buried ...
10) Underground mining is used when the coal is buried ...

21. Decide whether the following statements are true or false.

1) Coal is an inflammable black or brown sedimentary rock.
2) The pressure and heat from the top layers helped the plant remains turn into coal.
3) Bituminous coal formed about 100 to 300 million years ago is the least widespread rank of coal in the US.
4) Bituminous coal has a higher heating value than subbituminous coal.
5) Lignite is a relatively young coal deposit.
6) Surface mining is cheaper than underground mining.
7) Rocks and dirt, sulfur and unwanted materials are removed from coal at a preparation plant.
8) Coal is burnt by power plants to make steam.
9) Coke is used for smelting iron ore into iron.
10) The strength and flexibility are given to steel by the use of coke.

22. Answer the questions and give examples.

1) Why is coal a nonrenewable energy source?
2) What does the classification of coal depend on?
3) How much carbon does anthracite contain?
4) Do the steel and iron industries use bituminous coal? Why? Why not?
5) How much carbon does subbituminous contain?
6) What type of coal is crumbly and has a high moisture content?
7) What are the two methods of mining?
8) What is done at the plant?
9) When is coal ready to be shipped to market?
10) How is coke made?

23. Fill in the following table and answer the questions below.

Type of coal	Quantity of carbon	Quantity mined in the US	Heating value	Pecularities
Anthracite	…	…	the highest	...
…	…	about 50 %	…	…
…	…	…	…	100 mln years old
…	25–35 %	…	…	…

1) What type of coal is the most valuable? Why?
2) What type of coal is the most widespread in the USA?

24. What parts of the text can you define? Do they correspond to the paragraphs? Name each part.

1. _____ 4. _____
2. _____ 5. _____
3. _____ … _____

25. Find key words and phrases which best express the general meaning of each part.

26. Write a summary of Text B. Consult page 10.

Over to you

27. Discuss with your groupmates or in pairs what ranks of coal are mined in Belarus. (Find out additional information).

Language Focus

28. Find in the text the synonyms of the following words.

a) to hold – …
b) due to – …
c) type – …
d) to achieve – …
e) to aid – …
f) to utilize – …
g) to permit – …
h) to place – …
i) formation – …
j) to transform – …
k) to expose – …
l) to arrange – …

29. Find in the text the opposites of the following words.

a) renewable – …
b) top – …
c) dry – …
d) ancient – …
e) new – …
f) surface – …
g) high – …
h) tiny – …

30. Fill in the table with the derivatives.

Noun	Verb	Adjective
	to combust	
storage		
		dependent
		classified
	to contain	
deposit		
	to deepen	
		valuable
	to form	
generation		
usage		
		producible
	to moisten	
removal		
mining		
		allowable
creation		
	to strengthen	
		flexible
pressure		
	to clean	

31. Combine the words from the column on the left with the suitable nouns from the column on the right. Translate them into Russian.

1) sedimentary
2) nonrenewable
3) swampy
4) dead
5) top
a) plants
b) rock
c) value
d) layer
e) forests

6) plant	f) energy
7) heat	g) energy source
8) heating	h) rank
9) abundant	i) remains
10) raw	j) materials
11) moisture	k) mining
12) deep	l) machines
13) giant	m) reserves
14) coal	n) content
15) iron	o) furnaces
16) hot	p) ore

32. Fill in the correct prepositions, translate the phrases, then choose any five items and make up sentences of your own.

1) to be composed ___ sth.; 2) to come ___ the energy; 3) to cover ___ sth.; 4) to turn ___ sth.; 5) to classify ___ sth,; 6) to depend ___ sth.; 7) to account ___ 0,5%; 8) to form ___ high pressure; 9) ___ least; 10) to subject ___ extreme heat; 11) to locate ___ the mining site; 12) to remove coal ___ the ground; 13) to ship ___ market; 14) to bake ___ hot furnaces; 15) to smelt sth. ___ sth.

Active Vocabulary

33. Give Russian equivalents of the following words and phrases. Try to memorize them.

Nouns and noun phrases

diatom	sample	heart valve
liquid	crayon	propane
measurement	drilling	derrick
tools	pipe	treatment
ammonia	dishwashing liquid	molecule
barrel	refinery	pipeline
diesel	plastics	tire
silt		

Verbs and verbal phrases

to explore	to house
to reconfigure	to occupy

Adjectives	Adverbs
smelly	essentially selectively freely

Reading Task: *Text C*

34. Answer the following question and read the text below to check your answer.

Where do we use oil in everyday life?

Oil

Oil was formed from the remains of animals and plants (diatoms) that lived millions of years ago in a water environment before the dinosaurs. Over millions of years, the remains of these animals and plants were covered by layers of sand and silt. Heat and pressure from these layers helped the remains turn into what we today call crude oil (see Fig. 4).

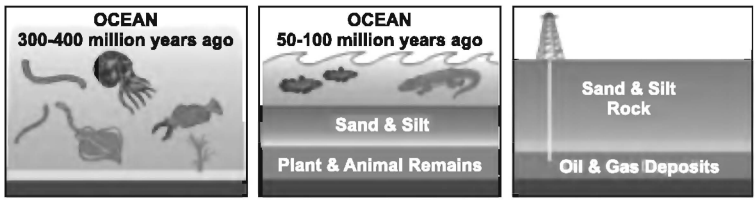


Fig. 4. Petroleum & natural gas formation

Crude oil is a smelly, yellow-to-black liquid and is usually found in underground areas called reservoirs. Scientists and engineers explore a chosen area by studying rock samples from the earth. Measurements are taken, and, if the site seems promising, drilling begins. Above the hole a derrick is built to house the tools and pipes going into the well. When finished, the drilled well will bring a steady flow of oil to the surface.

Crude oil is called «sweet» when it contains only a small amount of sulfur and «sour» if it contains a lot of sulfur. Crude oil is also classified by the weight of its molecules. «Light» crude oil

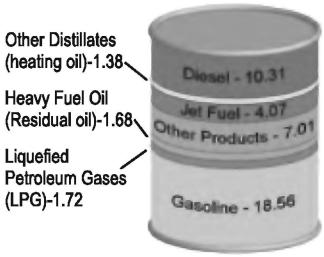


Fig. 5. Products made from a barrel of crude oil (Gallons)

flows freely like water, while «heavy» crude oil is thick like tar. Crude oil is measured in barrels (bbls).

The world's top five crude oil-producing countries are Russia, Saudi Arabia, United States, Iran, China.

After crude oil is removed from the ground, it is sent to a refinery by pipeline, ship, or barge. A typical refinery costs billions of dollars to build and millions more to maintain. A refinery runs 24 hours a day, 365 days a year and requires a large number of employees to run it. A refinery can occupy as much land as several hundred football fields.

At a refinery, different parts of the crude oil are separated into useable petroleum products. Essentially, refining breaks crude oil down into its various components, which then are selectively reconfigured into new products (see Fig. 5). All refineries perform three basic steps: separation, conversion and treatment.

One barrel of crude oil, when refined, produces about 19 gallons of finished motor gasoline, and 10 gallons of diesel, as well as other petroleum products. Most petroleum products are used to produce energy, to move merchandise and people, help make plastics, and do many other things. For instance, many people across the United States use propane to heat their homes.

Other products made from petroleum include ink, crayons, bubble gum, dishwashing liquids, deodorant, eyeglasses, CDs and DVDs, tires, ammonia, heart valves. [8]

Comprehension Check

35. Complete the following sentences according to the text.

1) Oil was formed from …
2) Scientists and engineers explore a chosen area by …
3) Crude oil is called «sweet» when it contains …
4) Crude oil is also classified by ...

5) «Light» crude oil flows …, while «heavy» crude oil is ...
6) After crude oil is removed from the ground, it is sent to …
7) A refinery runs …
8) One barrel of crude oil, when refined, produces …

36. Decide whether the following statements are true or false according to the text.

1) For years the remains of animals and plants were covered by layers of fine rocks.
2) Tools and pipes are housed in a derrick.
3) Crude oil is called «sour» if it contains a small quantity of sulfur.
4) A refinery is larger than a football field.
5) At a refinery, various parts of the crude oil are joined into useable petroleum products.
6) Propane is used by many Americans to heat their homes.

37. Answer the following questions and give examples.

1) What helped the remains to turn into crude oil?
2) Where is crude oil usually found in?
3) When does drilling begin?
4) What is crude oil measured in?
5) What are the main crude oil-producing countries?
6) What are the steps performed at all refineries?
7) What are most petroleum products used for?
8) What do products made from petroleum include?

38. What parts of the text can you define? Do they correspond to the paragraphs? Name each part.

1. _____ 4. _____
2. _____ 5. _____
3. _____ … _____

39. Find key words and phrases which best express the general meaning of each part.

40. Write a summary of Text C. Consult page 10.

Over to you

41. Make a presentation on the oil processing at a refinery. Find out additional information.

Language Focus

42. Unjumble the words.

Model: iol → oil

urdce →...	dliuqi →...	allong →...
ylare →...	lewl →...	uslufr →...
gtinh →...	ipep →...	rarelb →...
idesle →...	yinreref →...	leumetrop →...
mriean →...	tanimain →...	cdriker →...

43. Match the synonyms.

1) layer	a) exist
2) live	b) low-sulfur
3) explore	c) split
4) hole	d) shift
5) sweet	e) opening
6) instance	f) create
7) heavy	g) investigate
8) move	h) stratum
9) separate	i) weighty
10) break	j) conduct
11) perform	k) isolate
12) produce	l) example
13) water	m) marine
14) steady	n) stable

44. Combine the words from the column on the left with the suitable nouns from the column on the right. Translate them into Russian.

1) crude	a) well
2) smelly	b) countries
3) rock	c) liquid
4) drilled	d) components
5) small	e) samples

6) producing	f) valves
7) petroleum	g) oil
8) various	h) products
9) motor	i) amount
10) heart	j) gasoline

45. Form the nouns from the following verbs.

to refine →…	to form →…
to measure →…	to produce →…
to separate →…	to require →…
to convert →…	to perform →…
to treat →…	to house →…
to employ →…	to maintain →…
to explore →…	to choose →…
to study →…	to promise →…

46. Fill in the correct prepositions, translate the phrases, then choose any three items and make up sentences of your own.

1) to be formed ___ the remains ___ animals and plants; 2) to live ___ water environment; 3) to find ___ underground areas; 4) to bring a steady flow ___ oil ___ the surface; 5) to classify ___ the weight of molecules; 6) to measure ___ barrels; 7) to send ___ a refinery ___ pipeline; 8) a large number ___ employees; 9) to occupy ___ much land ___ several football fields; 10) to separate ___ useable products; 11) ___ well ___; 12) to be made ___ petroleum.

Active Vocabulary

47. Give Russian equivalents of the following words and phrases. Try to memorize them.

Nouns and noun phrases

well	limestone	mantle
vapor	strata	flammability
convenience	byproduct	tanker
illuminant		

Verbs and verbal phrases

to theorize
to issue

Adjectives

liquefying	decaying	primordial
calorific	ignited	extensive
pressurized	feasible	cryogenic

Adverbs

separately

Reading Task: *Text D*

48. Answer the following question and read the text below to check your answer.

Why is natural gas the most popular source of energy nowadays?

Natural Gas

Natural gas is a natural **mixture** of gaseous hydrocarbons found issuing from the ground or obtained from specially driven wells. The **composition** of natural gas varies in different localities. Its chief component, methane, usually makes up from 80% to 95%, and the balance is composed of varying amounts of ethane, propane, butane, and other hydrocarbon compounds. Some of the hydrocarbons found in gasoline also occur as vapors in natural gas; by liquefying these hydrocarbons, gasoline can be obtained.

Although commonly associated with petroleum **deposits** it also occurs separately in sand, sandstone, and limestone deposits. Some geologists **theorize** that natural gas is a byproduct of decaying vegetable matter in underground strata, while others think it may be primordial gases that rise up from the mantle. Because of its flammability and high calorific value, natural gas is used extensively as an illuminant and a fuel.

Natural gas was known to the ancients but was considered by them to be a supernatural phenomenon because, noticed only when ignited, it appeared as a mysterious fire bursting from the ground. One of the earliest **attempts** to harness it for economic use occurred in the early 19th cent. in Fredonia, N.Y. Toward the latter part of the 19th cent., large industrial cities began to make use of natural gas, and extensive pipeline systems have been constructed to transport gas.

Liquefied natural gas, or LNG, is natural gas that has been pressurized and cooled so as to liquefy it for convenience in ship-

ping and storage. The boiling point of natural gas is extremely low, and only in the 1970s did cryogenic technology **advance** enough to make the **production** and transport of LNG commerically feasible. Some of the natural gas moved to and from the United States is carried as LNG in special tankers. [8]

Comprehension Check

49. Finish the following sentences according to the text.

1) The composition of natural gas varies … .
2) The chief component of gas is … .
3) Some geologists theorize that natural gas is … .
4) Others think it may be … .
5) Natural gas is used extensively as an illuminant and a fuel because of its … .
6) One of the earliest attempts to harness it for economic use occurred in … .
7) Liquefied natural gas is natural gas that has been … .

50. Answer the following questions and give examples.

1) What is natural gas?
2) What is its chief component?
3) Does it occur in petroleum deposits only?
4) What are the main theories of gas origin?
5) What are its main properties?
6) Natural gas wasn't known to the ancients, was it? Why? Why not?
7) What was their idea about its origin?
8) When did the first attempt to harness it for economic use take place?
9) What is LNG?
10) What made the production and transport of LNG commercially feasible?

51. Fill in the table according to the text.

Components	Places of origin	Properties	Processes to liquefy
…	…	…	…

Over to you

52. Discuss with your groupmates or in pairs the advantages and disadvantages of natural gas as a source of energy.

Language Focus

53. Fill in the table with appropriate derivatives.

Specially, different, chief, occur, commonly, petroleum, theorize, byproduct, primordial, flammability, calorific, extensively, illuminant, consider, phenomenon, ignite, harness, industrial, pressurize, convenience, commercially, carry.

Noun	Verb	Adjective	Adverb
...	...	...	...

54. Form the nouns from the following verbs.

to compose →...
to differ →...
to localize →...
to liquefy →...
to theorize →...
to appear →...
to attempt →...
to construct →...
to pressurize →...
to occur →...

55. Choose the contextual meanings of the words written in bold in Text D.

1) **mixture**
   a) смесь
   b) смешивание
   c) микстура
   d) композиция

2) **deposit**
   a) депозит
   b) залежь
   c) отложение
   d) осадок

3) **composition**
   a) структура
   b) состав
   c) соединение
   d) сплав

4) **theorize**
   a) думать
   b) предсказывать
   c) теоретизировать
   d) допускать

5) **attempt**

a) попытка
b) проба
c) поступок
d) действие

6) **advance**

a) продвигаться
b) достигать
c) прогрессировать
d) наступать

7) **production**

a) производство
b) получение
c) изготовление
d) выработка

56. Use the words from the box to change the underlined words.

layer, believe, harness, built, at the beginning of, thought, to move, biomass, to use, extended, paranormal

1) Some geologists theorize that natural gas is a byproduct of decaying vegetable matter in underground strata.
2) Natural gas was known to the ancients but was considered by them to be a supernatural phenomenon.
3) One of the earliest attempts to harness it for economic use occurred in the early 19th cent. in Fredonia, N.Y.
4) Extensive pipeline systems have been constructed to transport gas.

It's important to know

57. Read the following text and decide whether the statements below are true or false according to the text. Correct the mistakes.

Measurement

A barrel's capacity often depends on who uses the term, or what it contains. For example:

1 barrel (bbl) of petroleum or related products = 42 gallons
1 barrel of Portland cement = 376 pounds
1 barrel of flour = 196 pounds
1 barrel of pork or fish = 200 pounds
1 barrel of (US) dry measure = 3,29122 bushels or 4,2104 cubic feet

A barrel may be called a "drum", but a drum usually holds 55 gallons! [1]

- 1 bbl of flour is more than 1 bbl of fish.
- "A barrel" is equivalent to "a drum".
- 1 bbl of cement is more than 1 bbl of pork.
- Dry bbl differs from liquid bbl.
- 1 gal is more than 1 bbl.

Language Development

58. Analyze the graph given below [11] (see Fig. 6) and make generalizations about the data. Use the following plan:

Plan:

1. What the graph shows.
2. What the numbers represent.
3. Make a thesis (a statement or an opinion that is presented with evidence in order to prove that it is true).
4. Support your thesis.
5. Make an appropriate conclusion.

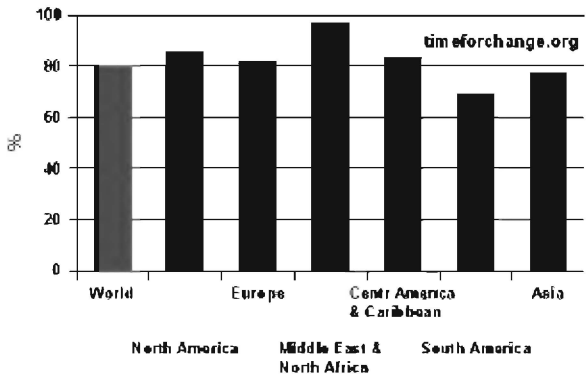


Fig. 6. Fossile fuels in % of total energy consumed

Use the phrases:

- The graph/diagram shows…
- A wide range in the percentage…
- A number of…
- According to the data…
- If to compare…
- We can sum up…

59. Translate the following texts into English using the active vocabulary.

1) Уголь – твердое топливо черного цвета, которое образовалось из остатков ископаемых растений. В каменноугольный и третичный периоды болотистая растительность постепенно образовала торфяники. Накопление новых остатков вызывало проседание осадочных пород. Повышение давления и выделение тепла привело к образованию лигнита (бурого угля), битуминозного угля и, при достаточно высокой температуре, – антрацита. Уголь залегает в виде пластов, в более глубоких пластах увеличивается содержание углерода и снижается содержание природного газа и влажности. Поэтому лигнит – менее качественное топливо, чем антрацит.

2) Природный газ – ископаемое топливо. Состоит из углеводородов, содержится в осадочных водах. Газ – газообразный компонент нефти, добывается из нефтяных скважин. Происхождение нефти и газа одинаково: разложение древних органических остатков. Перед использованием природного газа из него удаляют тяжелые углеводороды – бутан и пропан, которые сжигают и помещают в металлические баллоны. Оставшийся «сухой газ» подается потребителю по трубопроводу. Включает в себя метан и этан.

Follow Up

60. Read the texts of Unit II again and make notes under the following headings. Then use your notes to talk about *Traditional Sources of Energy*.

1. What wood fuel is and where it is used.
2. Coal origin, its properties, classification and harnessing.
3. Oil origin, its properties, refining process and harnessing.
4. What natural gas is, its origin, properties and process of liquefaction.

REVIEW

Check Your Knowledge

1. Choose the best option.

1) Total demand for fuel increased considerably with …
   a) the industrial revolution
   b) the technological process
   c) sustainable energy development

2) The most easily available form of fuel is…
   a) coal
   b) wood
   c) gas

3) All refineries perform … basic steps.
   a) two
   b) three
   c) four

4) Surface mining can be used when the coal is buried … underground.
   a) less than 100 feet
   b) more than 200 feet
   c) less than 200 feet

5) After coal comes out of the ground, it goes to …
   a) a refinery
   b) a preparation plant
   c) a treatment plant

6) Crude oil is …
   a) a smelly, yellow-to-black liquid
   b) a combustible black or brownish-black sedimentary rock
   c) mixture of gaseous hydrocarbons

7) Products made from petroleum include …
   a) plastics, tar, synthetic fibers, fertilizers, and medicines
   b) ink, bubble gum, dishwashing liquids, CDs and DVDs, ammonia, heart valves, etc.
   c) furniture, buildings, fittings, paper, etc.

2. Fill in the gaps.

1) The burning of _____ is currently the largest use of energyderived from a solid fuel biomass. (*wood/coal/oil)*
2) The energy content of _____ is dependent on the moisture content. (*coal/wood/oil)*
3) _____ is classified into four main types. (*coal/wood/oil*)
4) Crude _____ is a smelly, yellow-to-black liquid. (*coal/wood/oil*)
5) _____ is commonly associated with petroleum deposits. (*coal/oil/gas*)

3. Choose the underlined words and phrases which have mistakes.

1) Wood heat was [a)]gradually replaced by coal and later by [b)]fuel oil, natural gas and propane heating except in [c)]urban areas with [d)]available forests.
2) Coal is a [a)]renewable energy source because it takes [b)]millions of years [c)]to create.
3) Oil was formed from the remains of animals and [a)] plants that lived [b)]millions of years ago in a [c)]ground environment before [d)]the dinosaurs.
4) Natural [a)]oil was considered by [b)]the ancients to be [c)]a supernatural phenomenon because it appeared as a mysterious fire bursting from [d)]the ground.

4. Translate these phrases into English.

Природный газ, запасы нефти, воспламеняемость, нефтеперерабатывающий завод, промышленная революция, сжиженный газ, ископаемое топливо, происхождение нефти, использование угля, трубопровод, запасы угля, древесное топливо, побочные продукты, вырабатывать электроэнергию.

GAS SUPPLY

Start here

1. Choose the right word.

For hundreds of years, natural gas has been known as a very *(useful / useless)* substance. The Chinese *(discovered / invented)* a very long time ago that the energy in natural gas could be harnessed, and used to *(heat / cool)* water. In the early days of the natural gas industry, the gas was mainly used to *(light / heat)* streetlamps, and the occasional *(house / place)*.

There are so many *(different / special)* applications for this fossil fuel: commercially, in your home, in industry, and even in the transportation sector!

For example, energy from *(natural / man-made)* gas accounts *(for / at)* 24 percent of total energy consumed in the United States, making it a vital component of the nation's energy *(supply / demand)*.

2. The graph below [9] gives an idea of the natural gas use proportion per sector in the USA. Study it and complete the sentences below (see Fig. 7).

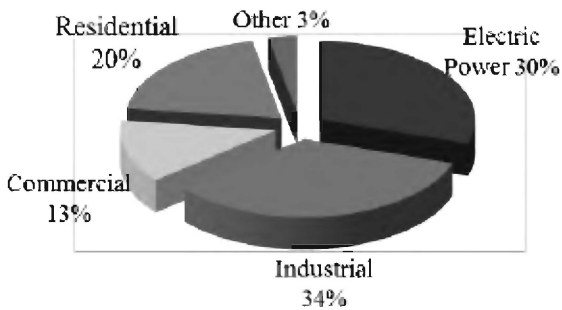


Fig. 7. Natural gas use by sector

- The industrial sector accounts for the _____ proportion of natural gas use in the United States.
- The residential sector consumes the third _____ quantity of natural gas.

- Commercial natural gas use accounts for _____.
- Electric power sector includes about _____.
- The usage of natural gas in residential sector is higher than _____.

Active Vocabulary

3. Give Russian equivalents of the following words and phrases. Try to memorize them.

Nouns and noun phrases

resurgence	consumer	self ignition
advancement	counterparts	requirement
infancy	appliance	

Verbs and verbal phrases

to disconnect	to plug
to offer	to provide

Adjectives

residential	versatile	comparable
distributed	reliable	

Adverbs

initially
approximately
considerably

Reading Task: *Text A*

4. Answer the following question and read the text below to check your answer.

What is natural gas used for in homes?

Residential Use

Natural gas is one of the cheapest forms of energy available to the residential consumer. In fact, natural gas has historically been much cheaper than electricity as a source of energy. According to the Department of Energy (DOE) natural gas costs less than 30 percent of the cost of electricity, per Btu.

Not only is natural gas cheap for the residential consumer, it also has **a number** of varied uses. The best known uses for natural gas around the home are natural gas heating and cooking. Cooking with a natural gas **range** or oven can provide many **benefits**, including easy temperature control, self ignition and self cleaning, as well as being approximately one-half the cost of cooking with an electric range.

Natural gas is one of the most popular fuels for residential heating. This popularity is also shown through the high proportion of new homes built with natural gas heating.

Despite this increase in the proportion of homes using natural gas the actual volume of natural gas consumed has not increased to the same degree due to increased efficiency of natural gas appliances. Modern top of the line gas furnaces can achieve efficiencies of over 90 percent (meaning that only 10 percent of the energy contained in the natural gas is lost as ***waste*** *heat).*

In addition to heating homes, natural gas can also be used to help cool houses, through natural gas powered air conditioning. Natural gas air conditioning is nothing new; in fact, it provided most of the air conditioning requirements of the 1940's and 50's. However, due to new advancements in technology and efficiency, natural gas air conditioning is experiencing resurgence in popularity. Although natural gas air conditioner units are initially more expensive than a comparable electric unit, they are considerably more efficient and require less maintenance.

Natural gas appliances are also rising in popularity due to their efficiency and cost effectiveness. Although many gas powered appliances are initially more expensive than their electric counterparts, they are commonly much cheaper to operate, have a longer expected life, and require relatively low maintenance. Some examples of other natural gas appliances include space heaters, clothes dryers, pool and jacuzzi heaters, fireplaces, barbecues, garage heaters, and outdoor lights. All of these appliances offer a safe, efficient, and economical alternative to electricity or other fuel sources.

Although natural gas has many uses, and can supply energy to a vast number of residential appliances, there are some energy requirements around the house which cannot be satisfied by natural gas. A television, or blender, or microwave, for instance, will likely never be powered directly by natural gas, but will instead require electrici-

ty. However, natural gas can still provide energy for these appliances at the home, by what is known as 'distributed generation'.

Distributed generation refers to using natural gas to generate electricity right on the doorstep. Natural gas fuel cells and microturbines both offer the residential consumer the **capacity** to disconnect from their local electric distributor, and generate just enough electricity to meet their needs. Although this technology is still in its infancy, it is very promising in being able to offer independent, reliable, efficient, environmentally friendly electricity for residential needs.

The very first natural gas fuel cell was installed in a house in Latham, New York, in July 1998. The system was plugged into the home's natural gas line as the fuel supply, and is now completely independent of any outside electricity. Because a significant amount of electricity is wasted when it is distributed through power lines from a central power plant to the home, on-site electric generation could lead to significantly higher energy efficiency, which **translates** to cost savings for the residential consumer. [9]

Comprehension Check

5. Decide whether the following statements are true or false according to the text.

1) Electricity has historically been much cheaper than natural gas as a source of energy.
2) Natural gas is used around the home for heating as well as cooling.
3) No energy contained in the natural gas is lost as waste heat.
4) Natural gas is widely used in air conditioning systems.
5) Natural gas air conditioner units are initially more expensive than a comparable electric unit.
6) Gas powered appliances require relatively low maintenance.
7) Such devices as a TV set or microwave will unlikely be powered directly by natural gas.
8) Natural gas fuel cells offer the residential consumer the capacity to disconnect from their local electric distributor.
9) The very first natural gas fuel cell was installed in a house in Latham, New York, in June 1998.
10) No electricity is wasted when it is distributed through power lines from a central power plant to the home.

6. Answer the following questions and give examples.

1) What is the lowest cost conventional energy source available for residential use?
2) What are the best known uses for natural gas around the home?
3) What are the benefits provided with cooking by natural gas?
4) What efficiency can modern top of line gas furnaces achieve?
5) Is natural gas air conditioning experiencing decline in popularity?
6) Can natural gas be used to cool houses? Why? Why not?
7) Why are natural gas appliances rising in popularity?
8) What are they?
9) Are electric or gas powered appliances cheaper to install? Why? Why not?
10) What energy requirements around the house cannot be satisfied by natural gas?

7. Translate the italicized passage in written form paying attention to the Participles.

8. Choose the best abstract for the text.

1. Natural gas has been harnessed in residential use for a long time and it is more efficient than electricity.
2. Natural gas can be used not only for heating and cooling but for a number of varied residential uses.
3. Natural gas is a cheap, efficient source of energy for the residential consumer and has a variety of uses around the house.

Over to you

9. Discuss with your groupmates or in pairs what is more ecologically friendly: electricity or natural gas.

10. Analyze the graph [11] and make generalizations about the data. Use the plan given below (see Fig. 8).

Plan:

1. What the graph shows.
2. What the numbers represent.
3. Make a thesis (a statement or an opinion that is presented with evidence in order to prove that it is true).
4. Support your thesis.
5. Make an appropriate conclusion.

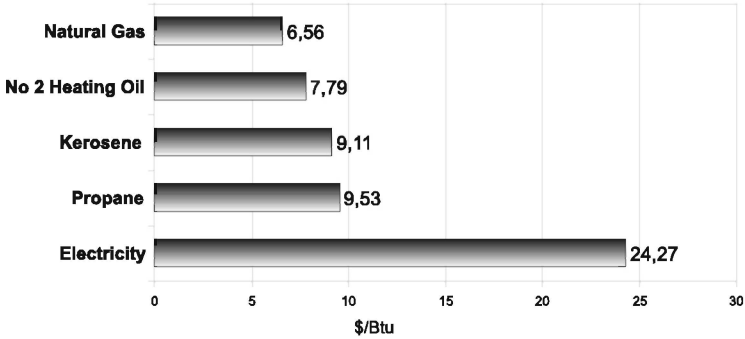


Fig. 8. Residential energy costs per btu

Use the phrases:

- The graph/diagram shows…
- A wide range in the percentage…
- A number of…
- According to the data…
- If to compare…
- We can sum up…

Language Focus

11. Choose the contextual meanings of the words written in bold in Text A.

1. **generation**
   a) создание
   b) образование
   c) формирование
   d) производство
2. **number**
   a) число
   b) сумма
   c) номер
   d) ряд
3. **range**
   a) шеренга
   b) ряд
   c) блок
   d) плита
4. **benefits**
   a) польза
   b) прибыль
   c) преимущество
   d) бенефис

5. **waste**

a) отходное
b) выделенное
c) излишнее
d) сбросное

6. **capacity**

a) мощность
b) вместимость
c) возможность
d) объем

7. **translates**

a) перемещает
b) приводит
c) переносит
d) переводит

12. Form the nouns from the following adjectives.

residential →…	efficient→…	local →…
natural →…	comparable →…	independent →…
electric →…	economical →…	reliable →…

13. Fill in the correct prepositions, translate the phrases, then choose any five items and make up sentences of your own.

1) A number __ varied uses; 2) cooking __ a natural gas;3) to show __ the proportion; 4) to increase __ the degree; 5) to contain __ the natural gas; 6) __ addition __ heating homes; 7) __ fact, 8) due __ new advancements __ technology; 9) resurgence __ popularity; 10) examples __ appliances; 11) alternative __ electricity; 12) to be satisfied __ natural gas; 13) to plug __ the home's natural gas line; 14) independent __ outside electricity; 15) to distribute __ power lines __ a central power plant __ the home.

14. Translate the following words and phrases into English using the vocabulary of the text.

Доступная форма, потребитель, обеспечивать выгоду, отопление жилого помещения, возрождение популярности, предполагаемый срок службы, комнатный обогреватель, требовать меньше текущего обслуживания, дешевый в эксплуатации, распределительное производство, топливный элемент, быть на начальной стадии развития, быть многообещающим, безвредный к окружающей среде, значительное количество, экономия в расходах.

Active Vocabulary

15. Give Russian equivalents of the following words and phrases. Try to memorize them.

Nouns and noun phrases

private enterprise	absorption	refrigerant
establishment	chiller	desiccant
humidity	appliance	outlet
fryer	griddle	venting options
CHP	disruption	commercial settings
CCHP	consistent electricity	

Verbs and verbal phrases		**Adjectives**
to fulfill	to integrate	multifunctional
to absorb	to evaporate	reciprocating
to expand		

Reading Task: *Text B*

16. Answer the following question and read the text below to check your answer.

What is natural gas used for in commercial sector?

Commercial Uses

Commercial uses of natural gas are very similar to residential uses. The commercial sector includes public and private enterprises, like office buildings, schools, churches, hotels, restaurants, and government buildings. The main uses of natural gas in this sector include space heating, water heating, and cooling. For restaurants and other establishments that require cooking facilities, natural gas is a popular choice to fulfill these needs (see Fig. 9).

Natural gas currently accounts for 13 percent of energy used in commercial cooling, but this percentage is expected to increase due to technological innovations in commercial natural gas cooling techniques. There are three types of natural gas driven cooling processes. Engine driven chillers use a natural gas engine, instead of an electric motor, to drive a compressor. With these systems, waste

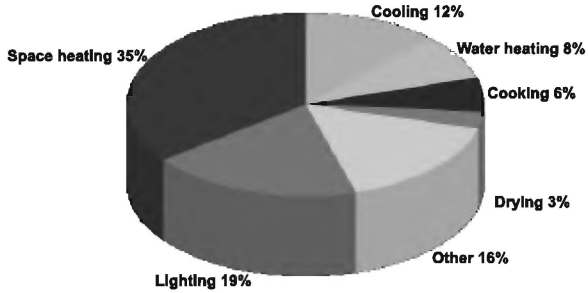


Fig. 9. Commercial energy use

heat from the gas engine can be used for heating applications, increasing energy efficiency. The second category of natural gas cooling devices consist of what are called absorption chillers, which provide cool air by evaporating a refrigerant like water or ammonia. These absorption chillers are best suited to cooling large commercial buildings, like office towers and shopping malls. The third type of commercial cooling system consists of gas-based desiccant systems. These systems cool by reducing humidity in the air. Cooling this dry air requires much less energy than it would to cool humid air.

Another area of growth in commercial natural gas use is in the food service industry as it is a flexible energy source in being able to supply the food service industry with appliances that can cook food in many different ways. New developments such as Nontraditional Restaurant Systems, which provide compact, multifunctional natural gas appliances for smaller sized food outlets such as those found in shopping malls and airports, are expanding the commercial use of natural gas. These types of systems can integrate a gas-fired fryer, griddle, oven, hot and cold storage areas, and multiple venting options in a relatively small space – providing the ease and efficiency of natural gas cooking while being compact enough to serve small kiosk type establishments.

In addition to traditional uses of natural gas, a number of technological advancements have allowed natural gas to be used to increase energy efficiency in commercial settings. Many buildings, because of their high electricity needs, have on-site generators that produce their own electricity. Natural gas powered reciprocating engines, turbines, and fuel cells are all used in commercial settings to generate electricity. These types of 'distributed generation' units

offer commercial environments more independence from power disruption, high-quality consistent electricity, and control over their own energy supply.

Another technological innovation brought about is combined heating and power (CHP) and combined cooling, heating and power (CCHP) systems, which are used in commercial settings to increase energy efficiency. These are integrated systems that are able to use energy that is normally lost as heat. For example, heat that is released from natural gas powered electricity generators can be harnessed to run space or water heaters, or commercial boilers. Using this normally wasted energy can dramatically improve energy efficiency. [10]

Comprehension Check

17. Complete the following sentences according to the text.

1) The commercial sector includes …
2) The main uses of natural gas in this sector include …
3) For restaurants natural gas is …
4) Natural gas currently …
5) Engine driven chillers use …
6) The second category consist of …
7) The third type of commercial cooling system consists …
8) Another area of growth in commercial natural gas use is …
9) In addition to traditional uses …
10) Another technological innovation is …

18. Answer the following questions and give examples.

1) What does the commercial sector include?
2) What are the main uses of natural gas in this sector?
3) How many types of natural gas driven cooling processes do you know? What are they?
4) Why is natural gas broadly harnessed in the food service industry?
5) How is natural gas used in buildings with high electricity needs?
6) What technological innovation to increase energy efficiency do you know?
7) According to the given graph, which commercial sector has the least natural gas harnessing?

19. Choose the underlined words and phrases which have mistakes.

1) The main uses of natural gas in [a] commercial sector include [b] space heating, water heating, and [c] cooking.
2) Natural gas currently [a] account for [b] 35 percent of energy used in commercial [c] space heating.
3) Waste heat from the gas engine can be used for [a] heating applications, [b] decreasing energy [c] efficiency.
4) Gas-based desiccant systems [a] cool by [b] raising humidity [c] in the air.
5) Natural gas is a [a] flexible energy source and [b] supply the [c] food service industry with appliances that can cook food.
6) Many buildings, because of their [a] high electricity needs, have on-site [b] distributors that produce their own [c] electricity.
7) CHP and CCHP are [a] disintegrated systems that are able to use energy that is [b] commonly lost as [c] heat.

20. Divide the text into logical parts and make an oral report on the text. Consult pages 29–30.

Language Focus

21. Fill in the table with appropriate derivatives.

Dramatically, on-site, expand, technique, normally, desiccant, account, choice, relatively, public, require, generation, currently, commercial, improve, refrigerant, high-quality, chiller, harness.

Noun	Verb	Adjective	Adverb
…	…	…	…

22. Combine the words from the column on the left with the suitable nouns from the column on the right. Translate them into Russian.

1) to require	a) cell
2) to fulfill	b) heating
3) desiccant	c) efficiency
4) fuel	d) facilities
5) distributed	e) innovations
6) space	f) system
7) technological	g) generation
8) energy	h) needs

23. Match the opposites.

1) heating	a) slightly
2) natural	b) humidifier
3) to improve	c) to decrease
4) to increase	d) to deteriorate
5) desiccant	e) extended
6) flexible	f) similar
7) compact	g) cooling
8) different	h) fixed
9) disruption	i) artificial
10) dramatically	j) combination

24. Translate the following words and phrases into English using the vocabulary of the text.

Коммерческое применение, частные предприятия, условия для приготовления пищи, удовлетворять потребностям, технологические достижения, запускать компрессор в действие, эффективность использования энергии (КПД), аппарат (емкость) с охлаждением, понижать влажность, новые разработки, многофункциональные устройства, нарушение подачи энергии, коммерческие бойлеры (котлы).

Active Vocabulary

25. Give Russian equivalents of the following words and phrases. Try to memorize them.

Nouns and noun phrases

waste treatment	steam reforming	incineration
multitude	ethane	feedstock
catalyst	recycling industry	formaldehyde
butane	dehumidification	acetic acid
additive	fueling	MTBE

natural gas absorption system
natural gas desiccant system

Verbs and verbal phrases

to extract
to trail

Reading Task: *Text C*

26. Answer the following question and read the text below to check your answer.

What is the natural gas used for in industry?

Uses In Industry

Natural gas has a multitude of industrial uses, including providing the base ingredients for such varied products as plastic, fertilizer, anti-freeze, and fabrics. In fact, industry is the largest consumer of natural gas, accounting for 43 percent of natural gas use across all sectors. Natural gas is the second most used energy source in industry, trailing only electricity.

Industrial applications for natural gas are many, including the same uses found in residential and commercial settings – heating, cooling, and cooking. Natural gas is also used for waste treatment and incineration, metals preheating (particularly for iron and steel), drying and dehumidification, glass melting, food processing, and fueling industrial boilers. Gases such as butane, ethane, and propane may be extracted from natural gas to be used as a feedstock for such products as fertilizers and pharmaceutical products.

Natural gas is converted to what is known as synthesis gas, which is a mixture of hydrogen and carbon oxides formed through a process known as steam reforming. In this process, natural gas is exposed to a catalyst that causes oxidization of the natural gas when brought into contact with steam. This synthesis gas, once formed, may be used to produce methanol (or Methyl Alcohol), which in turn is used to produce such substances as formaldehyde, acetic acid, and MTBE (methyl tertiary butyl ether) that is used as an additive for cleaner burning gasoline. Methanol may also be used as a fuel source in fuel cells.

In addition to these uses, there are a number of innovative and industry specific uses of natural gas. Natural gas desiccant systems, which are used for dehumidification, are increasingly popular in the plastics, pharmaceutical, candy, and even recycling industries. Adding a natural gas desiccant system to the manufacturing or drying environment allows industrial users to regulate more closely the amount of moisture in the air, leading to a more consistent and high-quality product.

Natural gas absorption systems are also being used extensively in industry to heat and cool water in an efficient, economical, and environmentally sound way. These industrial absorption systems are very similar to those used in commercial settings. [10]

Comprehension Check

27. Complete the following sentences according to the text.

1) Natural gas has a multitude of industrial uses, including...
2) Butane, ethane, and propane are used as a feedstock for ...
3) Synthesis gas is a mixture of ...
4) ... is used as an additive for cleaner burning gasoline.
5) Natural gas desiccant systems are increasingly popular in ...
6) Adding a natural gas desiccant system to the manufacturing or drying environment allows industrial users to ...

28. Correct the following statements.

1) Natural gas is the largest most used energy source in industry.
2) Synthesis gas may be used to produce formaldehyde, acetic acid and MTBE.
3) There are a few innovative and industry specific uses of natural gas.
4) The regulation of the amount of gas in the air leads to a more consistent and high-quality product.
5) The industrial absorption systems differ from those used in commercial settings.

29. Answer the following questions and give examples.

1) Is industry the largest consumer of natural gas? Why? Why not?
2) What are the industrial applications of natural gas?
3) What gases may be extracted from natural gas?
4) What is steam reforming?
5) Where may methanol be used as a fuel source?
6) What are natural gas desiccant systems used for?
7) Why are natural gas absorption systems being widely used in industry?

30. Find key words and phrases which best express the general meaning of each paragraph.

31. Write a summary of Text C. Consult page 10.

Language Focus

32. Combine the words from the column on the left with the suitable nouns from the column on the right. Translate them into Russian.

1) glass	a) application
2) base	b) treatment
3) industrial	c) reforming
4) pharmaceutical	d) ingredients
5) high-quality	e) system
6) waste	f) products
7) steam	g) melting
8) desiccant	h) products
9) absorption	i) systems
10) commercial	j) settings

33. Form the nouns from the following verbs.

to apply →…	to dehumidify →…	to absorb →…
to consume →…	to incinerate →…	to industrialize →…
to oxidize →…	to add →…	to increase →…

34. Form the verbs from the following nouns.

recyclability →…	provision →…	manufacturer →…
inclusion →…	conversion →…	extraction →…

35. Form the adjectives from the following nouns.

innovation →…	efficiency →…	environment →…
industry →…	economy →…	desiccant →…

36. Fill in the correct prepositions, translate the phrases, then choose any three items and make up sentences of your own.

1) to account ___ 43%; 2) to extract ___ natural gas; 3) to convert ___ synthesis gas; 4) a mixture formed ___ steam reforming; 5) to be exposed ___ a catalyst; 6) to bring ___ contact ___ steam; 7) ___ turn; 8) an additive ___ cleaner burning gasoline; 9) ___ addition ___ these uses; 10) the amount ___ moisture ___ the air; 11) to be similar ___ sth.

Active Vocabulary

37. Give Russian equivalents of the following words and phrases. Try to memorize them.

Nouns and noun phrases		
infrared heating	powder-coating	platinum catalyst
two-fold effect	co-firing	
direct contact water heater	technologies	
operational performance		
Verbs and verbal phrases		**Adjectives**
to regard		supplemental
to reap benefits		

Reading Task: *Texts D*

38. Read the following texts, translate the words in brackets and answer the questions below.

Infrared Heating Units

Infrared (IR) heating units provide an innovative and economic method of using natural gas to *(вырабатывать тепло)* in an industrial setting. They are very useful in the metals industry, as they provide *(инновационные методы)* to increase the efficiency of powder-coating manufacturing processes. Infrared heaters use *(природный газ)* to more *(эффективно)* and quickly heat materials used in this process. Natural gas is combined with a panel of ceramic fibers containing a platinum catalyst, *(вызывая)* a reaction with oxygen to *(значительно)* increase *(температуру)*, without even producing a *(пламя)*. Using natural gas in this manner has allowed industry members to *(увеличить)* the speed of their manufacturing process, as well as providing a more economic *(альтернатива, вариант)* to electric *(нагревательные приборы)*. [15]

- What do infrared heating units provide?
- Why are they useful?
- What is natural gas combined with?
- What are the advantages of natural gas usage in infrared heaters?

Direct Contact Water Heaters

Direct contact water heating is an application that *(работает)* by having the energy from the *(сжигание)* of natural gas transferred directly from the flame into the water. These systems are incredibly *(эффективны)* at heating water. *(Обычные промышленные водонагреватели)* operate in the 60–70 percent energy efficiency range. However, direct contact water can *(достигать)* efficiencies up to 99,7 percent! *(Очевидно)*, this leads to tremendous *(снижению себестоимости, экономии в расходах)* in industries where hot water is essential. [14]

- How do direct contact water heaters work?
- What efficiencies can direct contact water heaters achieve?
- What are the advantages of their usage?

Industrial Combined Heat and Power

Industrial *(потребители)* reap great benefits from operating natural gas Combined Heat and Power (CHP) and Combined Cooling, Heat, and Power (CCHP) *(систем)*. For instance, natural gas may be used to generate *(электричество)* needed in a particular industrial setting. The *(избыточное тепло и пар)* produced from this process can be *(использоваться)* to fulfill other industrial *(применения)*, including *(отопление помещений)*, water heating, and powering industrial *(бойлеры)*. Since industry is such a heavy user of energy, and *(особенно)* electricity, providing increased efficiency can *(экономить)* a great deal of money. The industrial sector is also subject to *(рассмотрения)* regarding harmful *(выбросы)*, and the burning attributes of natural gas help industry to *(снижать)* its emissions. [14]

- What benefits do industrial consumers reap from natural gas CHP and CCHP systems?
- What can the excess heat and steam be used for?
- Increased efficiency of CHP and CCHP systems can save a great deal of money, can't it?

Industrial Co-firing

Natural gas co-firing technologies are also helping to increase industrial energy efficiency, and reduce *(вредные)* atmospheric emissions. Co-firing is the process in which natural gas is used as a *(дополнительное топливо)* in the combustion of other fuels, such as coal, wood, and *(энергия биомассы)*. For example, a traditional

industrial wood boiler would simply *(сжигает)* wood to generate energy. *(Однако)*, in this type of boiler, a *(значительное)* amount of energy is *(теряется)*, and harmful emissions are very high. *(Добавление)* natural gas to the combustion *(смеси)* can have a two-fold effect. Natural gas *(выделяет)* fewer harmful *(веществ)* into the air than a fuel such as wood. Since the energy needed to power the natural gas boiler *(остается постоянным)*, adding natural gas to the combustion mix can reduce harmful emissions.

In addition, the *(эксплуатационная характеристика)* of the boiler, including its energy efficiency, can be *(улучшена)* by supplementing with natural gas. For instance, in wood fueled boilers, adding natural gas can *(компенсировать)* for the use of low grade wood, allowing it to combust more *(быстро)* and *(полностью)*. This type of co-firing can also be used in the generation of electricity, whether on-site or in a centralized *(электростанция)*. [14]

- What is co-firing?
- What are the benefits of natural gas co-firing technologies?
- How can the operational performance of a boiler be improved?
- Where can co-firing technologies be used?

39. Choose one text you like most and write an abstract in 1-2 sentences. **Consult page 14.**

Language Development

40. Read the following text about natural gas in the transportation sector and fill in the words listed below.

worldwide	*development*	*proliferation*
alternative	*combustion*	*meet*
compressed	*created*	*bi-fuel*
buses	*pollution*	*disadvantages*
stronger	*choice*	*reasons*
refueling	*safe*	*dissipates*
cost	*gasoline*	

Natural Gas in the Transportation Sector

Natural gas has long been considered an 1) _____ fuel for the transportation sector. In fact, the first internal 2) _____ engine vehicle to run on natural gas was 3) _____ by Etienne Lenoir in 1860 (see Fig. 10).

Fig. 10. The first Natural Gas Vehicle 1860

There are currently 150,000 Natural Gas Vehicles (NGVs) on the road in the United States today, and more than 5 million NGVs 4) _____. In recent years, technology has improved to allow for a 5) _____ of natural gas vehicles, particularly for fuel intensive vehicle fleets, such as taxicabs and public 6) _____. However, virtually all types of natural gas vehicles are either in production today for sale to the public or in 7) _____, from passenger cars, trucks, buses, vans, and even heavy-duty utility vehicles.

Despite these advances, a number of 8) _____ of NGVs prevent their mass-production. Limited range, trunk space, higher initial 9) _____, and lack of 10) _____ infrastructure pose impediments to the future spread of natural gas vehicles.

Most natural gas vehicles operate using 11) _____ natural gas (CNG).

Some natural gas vehicles are fueled by Liquefied Natural Gas (LNG). Some natural gas vehicles that exist today are 12) _____ vehicles, meaning they can use gasoline or natural gas, allowing for more flexibility in fuel 13) _____.

There are many 14) _____ why NGVs are increasing in abundance and popularity. Natural gas, being the cleanest burning alternative transportation fuel available today, offers an opportunity to 15) _____ the stringent environmental emissions standards.

In addition, natural gas is very 16) _____. Being lighter than air, in the event of an accident natural gas simply 17) _____ into the air, instead of forming a dangerous flammable pool on the ground like other liquid fuels. This also prevents the 18) _____ of ground water in the event of a spill. Natural gas fuel storage tanks on current NGVs are 19) _____ and sturdier than gasoline tanks.

Natural gas is also an economic alternative to 20) _____ and other transportation fuels. [9]

41. Try to draw the graph of the natural gas use proportion per sector in Belarus, then find out additional information and check yourself. Make a presentation in your group.

Follow Up

42. Read the texts of Unit III again and make notes under the following headings. Then use your notes to talk about Gas Supply.

1) Residential uses of natural gas.
2) Commercial uses of natural gas.
3) Industrial uses of natural gas.
4) Up-to-date units utilizing natural gas.
5) The benefits of natural gas harnessing.

REVIEW

Check Your Knowledge

Part 1

1. Fill in the gaps with the derivatives of the given words:

increase, emit, pollute, danger, environment, tradition, clean, surround

The Environmental Benefits of NGVs (natural gas vehicles)

One of the primary reasons for pursuing alternative fueled vehicle technology is to 1) ___ environmentally harmful 2) ___. It is estimated that vehicles on the road account for 60 percent of carbon monoxide pollution, 29 percent of hydrocarbon emissions, and 31 percent of nitrogen oxide (NOx) emissions. All of these emissions released into the atmosphere contribute to smog 3) ___, and increase the levels of 4) ___ ground level ozone. The 5) ___ effects of NGVs are much less detrimental than 6) ___ fueled vehicles.

Natural gas vehicles, when designed to run on natural gas alone, are among the cleanest vehicles in the world. In fact, the Honda Civic GX, released in 1997, has the 7) ___ internal combustion engine ever commercially produced (see Fig. 11). This natural gas powered automobile emits so few pollutants that in some large cities the emissions from the car are cleaner than the air 8) ___ it! California, with some of the

Fig. 11. Honda Civiec GX – Super Clean NGV

tightest clean air standards anywhere in the United States, has recognized selected natural gas vehicles as meeting and exceeding its most stringent standards. In 2008 the Honda Civic GX was awarded, for the fifth straight year, «America's Greenest Car» by the American Council for an Energy Efficient Economy (ACEE).

Natural gas vehicles are much cleaner burning than traditionally fueled vehicles due to the chemical **composition** of natural gas. While natural gas is **primarily** methane, gasoline and diesel fuels contain numerous other harmful compounds that are **released** into the environment through vehicle exhaust. While natural gas may emit small amounts of ethane, propane, and butane when used as a vehicular fuel, it does not emit many of the other, more harmful substances emitted by the **combustion** of gasoline or diesel.

Dedicated NGVs also produce, on average, 70 percent less carbon monoxide, 87 percent less non-methane organic gas, and 87 percent less то than traditional gasoline powered vehicles. [9]

2. Choose the contextual meanings of the words written in bold in the text above.

1. **composition**
   a) строение
   b) структура
   c) состав
   d) композиция
2. **primarily**
   a) первоначально
   b) сначала
   c) в основном
   d) главным образом
3. **released**
   a) выделенный
   b) высвобожденный
   c) избавленный
   d) раскрепленный
4. **combustion**
   a) озоление
   b) сжигание
   c) возгорание
   d) сгорание
5. **dedicated**
   a) специализированный
   b) назначенный
   c) выделенный
   d) посвященный

3. Choose the best abstract for the text.

1) The Honda Civic GX, natural gas powered automobile, was recognized as meeting and exceeding the most stringent standards.

2) All of the emissions from traditionally fueled vehicles contribute to environmental damage, that's why it is of great importance to develop natural gas vehicles.
3) Natural gas vehicles (e. g. Honda Civic GX) are much cleaner burning than traditionally fueled vehicles.

Part 2

4. Match the terms with their definitions.

a) ethane	*e) formaldehyde*	*i) catalyst*
b) application	*f) steam reforming*	*j) additive*
c) methanol	*g) butane*	*k) emission*
d) propane	*h) acetic acid*	*l) infrared*

1) a process in which methane from natural gas is heated, with steam, usually with a catalyst, to produce a mixture of carbon monoxide and hydrogen used in organic synthesis and as a fuel;
2) the act of applying to a particular purpose or use;
3) a colourless poisonous irritating gas with a pungent characteristic odour, made by the oxidation of methanol and used as formalin and in the manufacture of synthetic resins. Formula: HCHO;
4) a colourless odourless flammable gaseous alkane obtained from natural gas and petroleum: used as a fuel and in the manufacture of organic chemicals. Formula: C_2H_6;
5) a colourless flammable gaseous alkane found in petroleum and used as a fuel. Formula: $CH_3CH_2CH_3$;
6) a colourless volatile poisonous liquid compound used as a solvent and fuel. Formula: CH_3OH;
7) a colourless flammable gaseous alkane that exists in two isomeric forms, both of which occur in natural gas. The stable isomer, n-butane, is used mainly in the manufacture of rubber and fuels. Formula: C_4H_{10};
8) a substance that increases the rate of a chemical reaction without itself suffering any permanent chemical change;
9) a colourless pungent liquid, miscible with water, widely used in the manufacture of acetic anhydride, vinyl acetate, plastics, pharmaceuticals, dyes, etc. Formula: CH_3COOH;
10) any substance added to something to improve it, prevent deterioration, etc;

11) the part of the electromagnetic spectrum with a longer wavelength than light but a shorter wavelength than radio waves; radiation with wavelength between 0.8 micrometres and 1 millimetre;
12) energy, in the form of heat, light, radio waves, etc., emitted from a source.

5. Translate the following words and phrases into English using the vocabulary of the unit.

Отопление жилого помещения, предполагаемый срок службы, комнатный обогреватель, требование текущего обслуживания, дешевый в эксплуатации, распределительное производство, топливный элемент, экономия в расходах, коммерческое применение, частные предприятия, удовлетворять потребностям, технологические достижения, запускать компрессор в действие, эффективность использования энергии (КПД), многофункциональные устройства, коммерческие бойлеры (котлы), заправлять топливом бойлеры, преобразовывать в синтетический газ, вызывать окисление, получать из газа, регулировать количество влаги, осушение воздуха, сжигание отходов, установки инфракрасного нагрева, инновационные способы увеличения эффективности и скорости производства, значительно повышать температуру, не образуя открытый огонь, водные обогреватели прямого воздействия, снижать количество вредных атмосферных выбросов, дополнительное горючее, сгорать быстро и полностью, транспортные средства, работающие на газе, сжатый природный газ, сжиженный природный газ.

UNIT IV

ALTERNATIVE SOURCES OF ENERGY

Start here

1. Choose the right option.

Renewable Energy Sources

1) I am the energy in things that used to be alive. My energy is stored in trees, plants, and garbage. You can burn me to make heat and electricity. I can pollute the air when I am burned.
   a) *Petroleum*
   b) *Biomass*
   c) *Wind*

2) I am heat energy from inside the Earth. I heat underground rocks and water. Sometimes I am buried too deep to use. I am clean energy.
   a) *Wind*
   b) *Biomass*
   c) *Geothermal*

3) I am the energy in moving water. Dams can harness my energy. My power can make electricity. I am clean, cheap energy.
   a) *Wind*
   b) *Hydropower*
   c) *Natural Gas*

4) I make plants grow and I give you light. I make the wind blow and the rain fall. Today, it costs a lot to harness my energy. Photovoltaic cells can turn my energy into electricity.
   a) *Solar Energy*
   b) *Water*
   c) *Geothermal*

5) I am the energy in moving air. Some places have a lot of me, others only a little. Machines with blades capture my energy, turning it into electricity. I don't pollute the air, but cause noise pollution.
   a) *Nuclear Power*
   b) *Wind*
   c) *Solar Energy*

Nonrenewable Energy Sources

1) I look like a shiny black rock. I am a fossil fuel that is buried underground. I am often transported by river barges. I can pollute the air when I am burned to make electricity.
   a) *Coal*
   b) *Solar Energy*
   c) *Biomass*

2) I'm a gas with no color, no taste and no smell. Companies give me a funny smell so that you can tell if I escape. Companies drill wells to pump me from the ground. I am the cleanest burning fossil fuel.
a) *Petroleum*
b) *Oxygen*
c) *Natural Gas*

3) My energy is used to make electricity. I am used to make nuclear power. My energy does not pollute the air. My waste is radioactive and can be dangerous.
a) *Uranium*
b) *Wind*
c) *Solar Energy*

4) People drill wells to pump me from the ground and under the ocean. I am made into lots of things, like gasoline and plastics. I make more energy than any other energy source. I am a fossil fuel that pollutes the air when I am burned.
a) *Petroleum*
b) *Geothermal*
c) *Coal*

5) I am used on farms and in backyard grills. I am portable and can be shipped in tanks and bottles. I am a fossil fuel that is buried underground. I am clean burning.
a) *Biomass*
b) *Coal*
c) *Propane*

2. Translate the following sentences from Russian into English.

1) Все источники энергии могут подразделяться на возобновляемые и невозобновляемые.
2) Основным недостатком ископаемых видов топлива являются вредное воздействие на окружающую среду и то, что они быстрее иссякают, чем возобновляются.
3) Соответственно, необходимо более пристально рассмотреть возможность использования альтернативных источников энергии, таких как солнце, ветер, вода и т.д.

Active Vocabulary

3. Give Russian equivalents of the following words and phrases. Try to memorize them.

Nouns and noun phrases	Verbs and verbal phrases
photocell	to run out
surge of water	to capitalize
concern	to tap a resource
	to sluice

Adjectives	Adverbs
overcast	properly
non-replenishable	
adaptable	
habitable	

Reading Task: *Text A*

4. Answer the following question and read the text below to check your answer.

1) What is the difference between renewable and non-renewable energy sources?
2) Why is it so important to develop alternative energy sources?

The Pros and Cons of Alternative Energy

Oil and oil products make the world go round, some would say. Just about every piece of equipment or type of machinery uses oil to run. Oil, however, is a «non-replenishable» resource, and when it runs out, how will we run our equipment and machinery? In response to this question, many are trying to develop alternative sources of energy. Hopefully, these alternative sources will make the world less dependent on the limited supply of oil.

There are a number of types of alternative energy sources which have already been developed. They include:

• **Energy from the Sun**. Known as solar energy, this powerful and unlimited source of energy would offer us a very efficient alternative to oil, and it is a **free** resource.

If solar power were properly developed, it could easily become our primary **power** source. The use of solar power is especially attractive in areas that have long days and not much cloud cover. It is therefore ideal for less developed areas which may be far from the more traditional power sources.

The problem is that capitalizing on this powerful resource is not as simple as it seems. Locations with limited daylight hours or consistently overcast skies do not receive the amount of light required to store the energy. In addition, locations that do not have wide expanses of land available will not be able to **tap** this resource, since the photocells necessary to collect and store the sunlight require large tracts of land.

• **Wind.** The power of the wind was harnessed hundreds of years ago to run windmills, which directly ran mills on farmlands. The same principle can now be used, with the addition of storage capacity, to supply as much as 20% of our energy needs. In locations with strong winds, such as along the seashore, or in the mountains, wind can easily be harnessed to run generators to create electricity. This is an energy alternative that is safe and clean: no harmful carbon dioxide or other gases are produced in the creation of electricity through wind power. However, there are many areas that don't receive enough wind to make it a reliable source.

• **Hydroelectric Energy.** A powerful surge of water sluicing over a cliff creates a tremendous source of energy. This is the concept behind the construction of the many dams in the world today. Hydroelectric energy is another clean alternative to oil, since it does not produce waste or pollution. Energy produced by a dam is cheap and adaptable, but the cost of building a dam is very high and, without destroying entire potentially habitable areas, it is difficult to find locations for dams. Tidal energy – the power of water can also be harnessed on a smaller **scale** by the use of tidal flow. This alternative is very limited, however, since not every area has bodies of water with strong tidal flows, and the concern over the effect on fish and birds in the area raise many concerns. It is also not a steady source of energy, since tides move in twice daily movements. For this reason there are only nine workable sites for this type of power and only two being used.

• **Biomass.** Biomass can be considered a nice way of speaking of waste. Animal waste, rotten crops and grains, residues from wood mills and aquatic waste can all be fermented to form an **alcohol** that is comparable to coal in its energy producing powers. It also produces greenhouse gases, making it one of the less attractive alternative energy sources.

In addition to these more «natural» sources of energy production, fusion, fuel cells, nuclear, geothermal and hydrogen energies can be used for our future needs for power. These have negative environmental effects and so are questioned as alternative sources, but doesn't oil have as many, if not more negative effects? [6]

Comprehension Check

5. Decide whether the following statements are true or false according to the text.

1) Almost every piece of equipment or type of machinery uses gas to run.

2) There are few types of alternative energy sources which have already been developed.
3) Solar energy is a powerful and unlimited source of energy and it is a free resource.
4) The use of solar power is especially attractive in areas with limited daylight hours or consistently overcast skies.
5) The power of the wind has been developed recently.
6) Carbon dioxide or other gases can be produced in the creation of electricity through wind power.
7) Hydroelectric energy doesn't generate waste or pollution.
8) Energy produced by a dam is expensive and adaptable, but the cost of dam construction is very cheap.
9) There are only nine workable sites for tidal power and only two are in use.
10) Because of greenhouse gases, biomass is one of the less attractive alternative energy sources.

6. Answer the following questions.

1) What types of alternative energy sources have been developed yet?
2) Where is solar power especially attractive?
3) What is the main problem with capitalizing on solar power?
4) Where was the power of wind harnessed for the first time?
5) What types of landscape have strong winds?
6) Wind energy is safe and clean, isn't it? Prove it.
7) Why isn't wind power reliable in some areas?
8) What is the concept behind the construction of the many dams in the world today?
9) What are the pros and cons of tidal energy?
10) What wastes can be fermented to form an alcohol?
11) What are the pros and cons of biomass?
12) What other energies can be used for our needs in power?

7. What parts of the text can you define? Do they correspond to the paragraphs? Name each part.

1. _____ 4. _____
2. _____ 5. _____
3. _____ … _____

8. Find key words and phrases which best express the general meaning of each part.

9. Make an oral report on Text A. Consult pages 29-30.

Over to you

10. Discuss with your groupmates or in pairs:

1) What are the advantages and disadvantages of alternative energy sources?
2) What are the prospects of alternative energy sources harnessing in Belarus? (Find out additional information).

Language Focus

11. Choose the contextual meanings of the words written in bold in Text A.

1. **free**
   a) свободный
   b) независимый
   c) бесплатный
   d) незанятый
2. **power**
   a) сила
   b) способность
   c) мощность
   d) энергия
3. **tap**
   a) улавливать
   b) отводить
   c) принимать
   d) выпускать
4. **scale**
   a) масштаб
   b) шкала
   c) величина
   d) весы
5. **alcohol**
   a) алкоголь
   b) этанол
   c) спирт
   d) спиртной напиток

12. Match the English and Russian equivalents.

a) limited supply	1) пасмурное небо
b) primary power source	2) мощная волна
c) overcast skies	3) запускать генераторы
d) large tracts of land	4) переливаясь через утес
e) storage capacity	5) подходящие участки

f)	to run generators	6)	акватические отходы
g)	a powerful surge	7)	ограниченное количество
h)	sluicing over a cliff	8)	основной источник энергии
i)	workable sites	9)	большие участки земли
j)	aquatic waste	10)	аккумулирующая способность

13. Form the nouns from the following adjectives.

dependent →...	attractive →...	habitable →...
alternative →...	available →...	workable →...
powerful →...	harmful →...	traditional →...
unlimited →...	adaptable →...	environmental →...

14. Read the following text and translate the words in brackets. Make an abstract of the text in 2-3 sentences. Consult page 14.

In 2009 substantial investments were made to improve Belarus' *(возобновляемые источники)* capacity, with proposals including three hydroelectric plants, several *(биомасса)* and combined heat and power plants, plus the *(строительство)* of over 2,400 *(ветряки)*. Of all renewables, *(биотопливо)* is most *(привлекательны)* to Belarus because of the vast *(площади)* of forest and farmland across the republic.

Biofuel facilities are being constructed in the southern towns of Mozyr and Bobruisk to *(производить)* 650 million litres of bioethanol a year, and *(химический)* company Azot is experimenting with the production of methyl ether from rape oil.

Biomass also offers ways to *(восстанавливать)* land *(загрязненный)* by the Chernobyl disaster as the growing and harvesting process helps *(очистка)* the land. [6]

Reading Task: *Text B*

15. Look through the following interview with a famous professor on harnessing alternative sources of energy. Read it in pairs. Translate from Russian into English and vice versa.

Reducing Oil Consumption – Is it really Possible?

1) **Interviewer**: Каждому из нас изо дня в день необходима энергия в той или иной форме для удовлетворения необходимых потребностей. Большинство из нас используют неф-

тяные источники непосредственно или опосредованно для производства энергии. Но, прежде чем начать разговор о снижении потребления нефти, возможно, нам стоит подсчитать, сколько нефтетоплива мы потребляем?

Professor: It is a good idea to evaluate your energy needs. For example, US Transportation sector accounts for approximately 2/3rd of the total oil consumption in America. Only when you have your total energy requirement lined up, you will be able to decide whether it is possible for you to cut on some of those requirements. Also, the consideration can be placed on different alternatives that you can use for generating that energy.

Oil consumption is probably the only alternative for transportation. However, oil consumed for generating power can instead be controlled. It is possible to use the alternative energy sources in the desired quantity.

I: Каково Ваше мнение, возможно ли полностью отказаться от потребления нефти посредством использования альтернативных источников энергии?

P: Of course, solar energy systems, hydropower, wind power, bio-gas are few options available. If you are a marketing person, it would probably be impossible to reduce your dependence on oil. However, if you are running a restaurant business, you can use solar power instead for cooking food, wind power to run machines and so on.

I: Существует ли связь между снижением потребления нефти и альтернативными источниками энергии?

P: You can even create alternative energy on your own and can thus, reduce your oil dependence.

2) **I:** Так какие энергетические источники могут заменить нефть полностью?

P: Let's explore the various alternatives which have emerged in recent times with the advent of technology. We all know that the earth has limited stock of non-renewable sources of energy like coal and oil. On the other hand, renewable energy sources like solar energy, wind energy, bio-gas is available in unlimited quantities and can thus, help us solve the energy crisis that might arise in the future. Alternative sources are a key towards future power generation.

I: С увеличением уровня парниковых газов и глобального потепления климата, возросшая ответственность ложится не только на правительство, но и на каждого гражданина.

P: Absolutely! And we all are to deal with the energy problems seriously.

I: Какие источники энергии являются наиболее разработанными на сегодняшний день?

P: Solar power and wind power are the two most researched forms of alternative energy. Alternative sources are natural form of energy and are more ecologically friendly. Various worldwide committees are trying to research the possible uses of these alternative sources of energy. Also, the discovery of new alternative energy sources is a field where a lot of investment is being made.

3) **I:** Многие уже активно используют альтернативные источники энергии в повседневной жизни. А существуют ли какие-нибудь данные на этот счет?

P: Within 15 years, renewable energy shall be able to generate sufficient electricity to light up more than 40 million homes. This in turn will help the world to offset oil imports for 70 days.

I: Каковы очевидные преимущества альтернативных источников энергии?

P: They help to reduce air and water pollution by producing lesser amount of carbon monoxide. They will help to reduce dependence on oil rich nations and can thus provide a chance to the domestic economy to grow. Alternative energy sources can facilitate creation of greener jobs, that spread little pollution and at the same time train technicians to make solar panels and generators.

I: Спасибо за интервью, надеюсь, теперь стало очевидным, что будущее мировой экономики полагается на энергию, воспроизводимую альтернативными источниками.

Active Vocabulary

16. Give Russian equivalents of the following words and phrases. Try to memorize them.

Nouns and noun phrases

elevation
injustice

Verbs and verbal phrases

to evaporate
to capture
to spin
to absorb
to rot
to penetrate

Adjectives

inexhaustible
viable
low-impact

17. Read the following international words and mind the stressed syllables.

basis	atmosphere	to minimize
turbine	meter	radiator
hydroelectric	to absorb	percent
to generate	equivalent	financial

Reading Task: *Text C*

18. Answer the following question and read the text below.

Where can you see solar panels on?

1. garden lamps
2. _____
3. _____
4. ...

How Solar Energy Works

Solar energy – power from the sun – is free and inexhaustible. This vast, clean energy resource represents a viable alternative to the fossil fuels that currently pollute our air and water, threaten our public health, and contribute to global warming. Failing to take advantage of such a widely available and low-impact resource would be a grave injustice to our children and all future generations.

In the broadest sense, solar energy supports all life on Earth and is the basis for almost every form of energy we use. The sun makes plants grow, which can be burned as «biomass» fuel or, if left to rot in swamps and compressed underground for millions of years, in the form of coal and oil. Heat from the sun causes temperature differences between areas, producing wind that can power turbines. Water evaporates because of the sun, falls on high elevations, and rushes down to the sea, spinning hydroelectric turbines as it passes. But solar energy usually refers to ways the sun's energy can be used to directly generate heat, lighting, and electricity.

The Solar Resource. The amount of energy from the sun that falls on Earth's surface is enormous. All the energy stored in Earth's reserves of coal, oil, and natural gas is matched by the energy from just 20 days of sunshine. Outside Earth's atmosphere, the sun's energy contains about 1,300 watts per square meter. About one-third of this light is reflected back into space, and some is absorbed by the atmosphere (in part causing winds to blow).

By the time it reaches Earth's surface, the energy in sunlight has fallen to about 1,000 watts per square meter at noon on a cloudless day. Averaged over the entire surface of the planet, 24 hours per day for a year, each square meter collects the approximate energy equivalent of almost a barrel of oil each year, or 4,2 kilowatt-hours of energy every day.

This figure varies by location and weather patterns. Deserts, with very dry air and little cloud cover, receive the most sun–more than six kilowatt-hours per day per square meter. Northern climes get closer to 3,6 kilowatt-hours.

Passive Solar Design for Buildings. One simple, obvious use of sunlight is to light our buildings. If properly designed, buildings can capture the sun's heat in the winter and minimize it in the summer, while using daylight year-round. Buildings designed in such a way are utilizing passive solar energy–a resource that can be tapped without mechanical means to help heat, cool, or light a building. South-facing windows, skylights, awnings, and shade trees with the sun in mind can be comfortable and beautiful places to live and work.

Solar Heat Collectors. Besides using design features to maximize their use of the sun, some buildings have systems that actively gather and store solar energy. Solar collectors, for example, sit on the rooftops of buildings to collect solar energy for space heating, water heating, and space cooling. Most are large, flat boxes painted black on the inside and covered with glass. In the most common design, pipes in the box carry liquids that transfer the heat from the box into the building. This heated liquid–usually a water-alcohol mixture to prevent freezing–is used to heat water in a tank or is passed through radiators that heat the air. Oddly enough, solar heat can also power a cooling system. Today, about 1,5 million U.S. homes and businesses use solar water heaters. In other countries, solar collectors are much more common; Israel requires all new homes and apartments to use solar water heating, and 92 percent of the existing homes in Cyprus already have solar water heaters. With natural gas prices at historically high levels, solar water and space heaters have become much more economic.

The Future of Solar Energy. Solar energy technologies are poised for significant growth in the 21st century. More and more architects and contractors are recognizing the value of passive solar and learning how to effectively incorporate it into building designs. Solar hot water systems can compete economically with conventional systems in some areas. And as the cost of solar PV continues to decline, these systems will penetrate increasingly larger markets. In fact, the solar PV industry aims to provide half of all new U.S. electricity generation by 2025.

Aggressive financial incentives in Germany and Japan have made these countries global leaders in solar deployment for years. [6]

Comprehension Check

19. Decide whether the sentences are true or false according to the text.

1) Energy from the sun is the basis for almost every form of energy we use.
2) Solar energy occurs as a result of temperature differences between areas.
3) Solar energy is considered to be the ways the sun's energy is used to directly generate heat.
4) The sun's energy contains about 1,500 watts per square meter outside Earth's atmosphere.
5) The sun's energy reduces to about 1,000 watts per square meter at noon on a cloudy day.
6) Each square meter collects the energy equivalent of 5,2 kilowatt-hours of energy every day.
7) Skylights, south-facing windows are the examples of passive solar energy.
8) Solar collectors are installed on the roofs of buildings to accumulate solar energy for heating.
9) Solar collectors use a water-alcohol mixture to prevent drying up.
10) About 1,5 million German homes and enterprises use solar water heaters currently.
11) Solar hot water systems have become a good alternative to conventional systems in some areas.
12) The purpose of the solar PV industry is to provide half of all new U.S. electricity generation by 2035.

20. Answer the following questions and give examples.

1) What are the main advantages of solar energy?
2) What does solar energy contribute to?

3) How many watts per square meter does the sun's energy contain?
4) How much energy on average does square meter collect for a year?
5) How does this figure vary?
6) What is an obvious use of sunlight for buildings?
7) What are the systems that gather and store solar energy?
8) What countries with active harnessing of solar power for buildings do you know?
9) What are the prospects of solar energy technologies in the nearest future?
10) What countries are leaders in solar deployment?

21. Find key words and phrases which best express the general meaning of each paragraph.

22. Write a summary of Text B. Consult page 10.

Over to you

23. Discuss with your groupmates or in pairs:

1) What is the main problem with solar panels usage in Belarus?
2) Is it possible to use energy from the sun for industrial purposes in our Republic? Why? Why not?

Language Focus

24. Fill in the table with appropriate derivatives.

Awning, beautiful, difference, comfortable, common, outside, mixture, existing, alternative, properly, rot, evaporates, directly, contains, minimize, oddly.

Noun	Verb	Adjective	Adverb
…	…	…	…

25. Match the appropriate derivatives and translate them into Russian.

1) to exhaust	a) injustice
2) current	b) vapor
3) to justify	c) south-facing
4) to evaporate	d) to affect
5) cloudy	e) currently

6) sunlight
7) equivalent
8) sphere
9) to localize
10) to face
11) to require
12) effectively

f) inexhaustible
g) atmosphere
h) cloudless
i) requirement
j) sunny
k) equal
l) location

26. Give the definitions of the words given below in your own words in written form.

to maximize
inexhaustible
appropriate
currently

enormous
mechanical means
effectively
underground

27. Translate the following words and phrases into English using the vocabulary of the text.

Энергия солнца, жизнеспособная альтернатива, широко доступный, воспользоваться преимуществом, большое упущение (несправедливость), в наиболее широком смысле, разница в температурном режиме, производить непосредственно, поверхность Земли, расположение и синоптическая ситуация, при надлежащем проектировании, активно накапливать и сохранять, нагретая жидкость, водно-спиртовой раствор, предотвращать замораживание, значительный рост, осознавать ценность, традиционные системы.

28. Look at the diagram below (fig. 12) and label it with the words in the box.

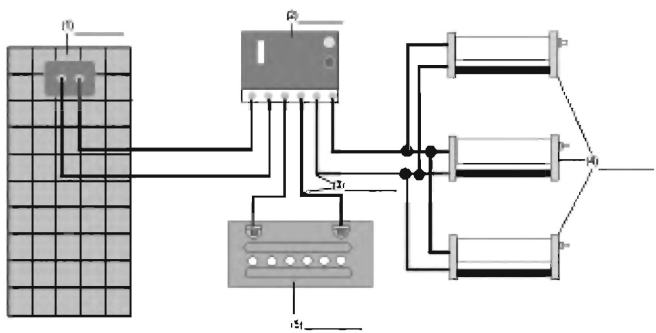


Fig. 12. The solar power system

battery	*cables*	*controller*	*lamps*	*solar panel*

It's important to know

29. Read and translate into Russian the manual for the solar panel battery.

How does the solar power system work? The panel converts the Sun's energy into a direct current (DC) electric current. The current flows to the controller. Then it can flow from the controller to the lamps. Or it can flow from the controller into the battery. The battery stores the electricity. The current can flow from the battery into the lamps through the controller.

If the Sun shines, the DC current can flow from the panel, through the controller and into the lamps. If the Sun doesn't shine, the current can flow from the battery, through the controller and into the lamps. If the lamps are off, the current can flow from the panel, through the controller, and into the battery.

The controller controls the flow of the current. If the battery is full, the controller stops the flow from the panel into the battery. If the battery is empty, the controller stops the flow from the battery into the lamps. [1]

30. Identify the equipment from the description. There are two extra words.

a) controller	*c) cable*	*e) electrical current*
b) solar panel	*d) battery*	*f) radiator*

1) It converts energy from the Sun into electricity.
2) It stores the electricity.
3) It controls the flow of the current.
4) It flows from the panel, through the controller and into the lamps.

31. These are the main parts of the system. Match the items with their specifications. Give abbreviations in words.

1) solar panel	a) 12V 8W
2) controller	b) DC
3) battery	c) 5A
4) lamps	d) 60W
5) electrical current	e) 12V 100Ah

32. Summarize the main parts of the system. Start with: "The system consists of a sixty watt solar panel, ..."

Active Vocabulary

33. Give Russian equivalents of the following words and phrases. Try to memorize them.

Nouns and noun phrases

windmill	paddle wheel	shaft
sawmill	airfoil	cluster
altitude	tax break	propeller-type blades
sail	axis	wind tunneling
wind farm	electrical grid	public utility company
green pricing program		

Verbs and verbal phrases

to rush	to cause
to reverse	to scatter
to rotate	to capture
to span	

Reading Task: *Text D*

34. Answer the following question and read the text below to check your answer.

What is the principle of harnessing wind power?

Energy from Wind

Wind is simple air in motion. It is caused by the uneven heating of the earth's surface by the sun. Since the earth's surface is made of very different types of land and water, it absorbs the sun's heat at different rates.

During the day, the air above the land heats up more quickly than the air over water. The warm air over the land expands and rises, and the heavier, cooler air rushes in to take its place, creating winds. At night, the winds are reversed because the air cools more rapidly over land than over water (see Fig. 13).

In the same way, the large atmospheric winds that circle the earth are created because the land near the earth's equator is heated more by the sun than the land near the North and South Poles.

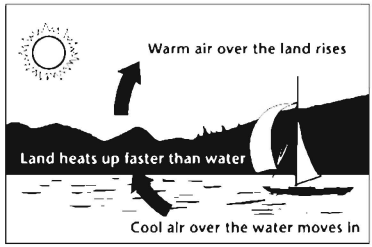


Fig. 13. Air in motion

Today, wind energy is mainly used to generate electricity. Wind is called a renewable energy source because the wind will blow as long as the sun shines.

Since ancient times, people have harnessed the winds energy. Over 5,000 years ago, the ancient Egyptians used wind to sail ships on the Nile River. Later, people built windmills to grind wheat and other grains. The earliest known windmills were in Persia (Iran). These early windmills looked like large paddle wheels. Centuries later, the people of Holland improved the basic design of the windmill. They gave it propeller-type blades, still made with sails. Holland is famous for its windmills.

American colonists used windmills to grind wheat and corn, to pump water, and to cut wood at sawmills. The oil shortages of the 1970s changed the energy picture for the country and the world. It created an interest in alternative energy sources, paving the way for the re-entry of the windmill to generate electricity.

Like old fashioned windmills, today's wind machines use blades to collect the wind's kinetic energy. Windmills work because they slow down the speed of the wind. The wind flows over the airfoil shaped blades causing lift, like the effect on airplane wings, causing them to turn. The blades are connected to a drive shaft that turns an electric generator to produce electricity.

With the new wind machines, there is still the problem of what to do when the wind isn't blowing. At those times, other types of power plants must be used to make electricity.

There are two types of wind machines (turbines) used today based on the direction of the rotating shaft (axis): horizontal-axis wind machines and vertical-axis wind machines. The size of wind machines varies widely. Small turbines used to power a single home or business may have a capacity of less than 100 kilowatts. Some large commercial sized turbines may have a capacity of 5 million watts, or 5 megawatts. Larger turbines are often grouped together into wind farms that provide power to the electrical grid.

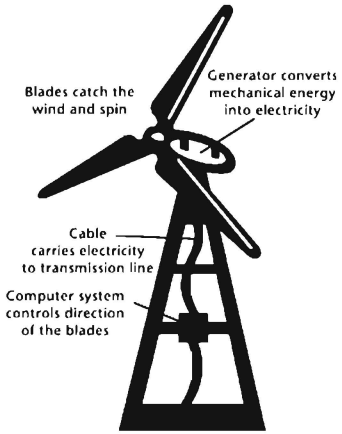


Fig. 14. Horizontal wind machine

Horizontal-axis. Most wind machines being used today are the horizontal-axis type. Horizontal-axis wind machines have blades like airplane propellers. A typical horizontal wind machine stands as tall as a 20-story building and has three blades that span 200 feet across. The largest wind machines in the world have blades longer than a football field! Wind machines stand tall and wide to capture more wind (see Fig. 14).

Vertical-axis. Vertical-axis wind machines have blades that go from top to bottom and the most common type looks like a giant two-bladed egg beaters. The type of vertical wind machine typically stands 100 feet tall and 50 feet wide. Vertical-axis wind machines make up only a very small percent of the wind machines used today.

Wind power plants, or wind farms as they are sometimes called, are clusters of wind machines used to produce electricity. A wind farm usually has dozens of wind machines scattered over a large area. The world's largest wind farm, the Horse Hollow Wind Energy Center in Texas, has 421 wind turbines that generate enough electricity to power 220,000 homes per year.

Unlike power plants, many wind plants are not owned by public utility companies. Instead they are owned and operated by business people who sell the electricity produced on the wind farm to electric utilities. These private companies are known as Independent Power Producers.

Operating a wind power plant is not as simple as just building a windmill in a windy place. Wind plant owners must carefully plan where to locate their machines. One important thing to consider is how fast and how much the wind blows.

As a rule, wind speed increases with altitude and over open areas with no windbreaks. Good sites for wind plants are the tops of smooth, rounded hills, open plains or shorelines, and mountain gaps that produce wind tunneling.

Wind speed varies throughout the country. It also varies from season to season.

New technologies have decreased the cost of producing electricity from wind, and growth in wind power has been encouraged by tax breaks for renewable energy and green pricing programs. Many utilities around the country offer green pricing options that allow customers the choice to pay more for electricity that comes from renewable sources.

Most of the wind power plants in the world are located in Europe and in the United States where government programs have helped support wind power development. The United States ranks second in the world in wind power capacity, behind Germany and ahead of Spain and India. Denmark ranks number six in the world in wind power capacity but generates 20 percent of its electricity from wind.

In the 1970s, oil shortages pushed the development of alternative energy sources. In the 1990s, the push came from a renewed concern for the environment in response to scientific studies indicating potential changes to the global climate if the use of fossil fuels continues to increase. Wind energy is an economical power resource in many areas of the country. Wind is a clean fuel; wind farms produce no air or water pollution because no fuel is burned. Growing concern about emissions from fossil fuel generation, increased government support, and higher costs for fossil fuels (especially natural gas and coal) have helped wind power capacity grow substantially over the last 10 years.

The most serious environmental drawbacks to wind machines may be their negative effect on wild bird populations and the visual impact on the landscape. To some, the glistening blades of windmills on the horizon are an eyesore; to others, they're a beautiful alternative to conventional power plants. [6]

Comprehension Check

35. Put the following sentences in the correct order according to the text.

1) ___ A typical horizontal wind machine stands as tall as a 20-story building and has three blades that span 200 feet across.
2) ___ Over 5,000 years ago, the ancient Egyptians used wind to sail ships on the Nile River.
3) ___ Government programs adopted in Europe and in the US support wind power development.
4) ___ The large atmospheric winds that circle the earth are created because the land near the earth's equator is heated more by the sun than the land near the North and South Poles.

5) ___ There are horizontal-axis and vertical-axis wind machines.
6) ___ Wind power plants are clusters of wind machines used to produce electricity.
7) ___ Wind is caused by the uneven heating of the earth's surface by the sun.
8) ___ Like old fashioned windmills, today's wind machines use blades to collect the wind's kinetic energy.
9) ___ Vertical-axis wind machines have blades that go from top to bottom and usually look like a giant two-bladed egg beaters.
10) ___ Wind plants may be owned by public utility companies or business people.
11) ___ New technologies have decreased the cost of producing electricity from wind, and growth in wind power has been encouraged by tax breaks for renewable energy and green pricing programs.
12) ___ Potential changes to the global climate pushed the development of alternative energy sources in the 1990s.

36. Make the following statements true according to the text.

1) The air above the water heats up more quickly than the air over land during the day.
2) Contrary the air cools more slowly over land than over water and the winds are reversed at night.
3) The earliest known windmills were in Holland.
4) American colonists created an interest in alternative energy sources.
5) The blades are joined to a drive shaft that turns a windmill to produce electricity.
6) Small turbines may have a capacity of more than 100 kilowatts and some large turbines may have a capability of 5 megawatts.
7) The most popular wind machines are vertical-axis.
8) Many wind plants as well as power plants are not owned by public utility companies.
9) Operating a wind power plant is easier than just building a windmill in a windy place.
10) Wind speed remains constant throughout the country but it varies from season to season.
11) The cost of producing electricity from wind has been increased by new technologies.

12) The negative effect on wild bird populations and the visual impact on the landscape are the most serious environmental advantages of wind machines.

37. Answer the following questions and give examples.

1) Why does the earth's surface absorb the sun's heat at different rates?
2) What is wind energy mainly used to?
3) Why is wind called a renewable energy source?
4) How did the early windmills look like?
5) Who improved the basic design of the windmill later?
6) What changed the energy picture for the world in the 1970s?
7) How do windmills work?
8) What is the problem with the new wind machines? What is the solution?
9) What are wind machines based on?
10) What are wind farms?
11) What is the difference between the horizontal-axis and vertical-axis wind machines?
12) The world's largest wind farm is located in Texas, isn't it?
13) Who owns wind plants?
14) What must be considered before building a wind plant?
15) What sites are suitable for wind plants?
16) What has growth in wind power been encouraged by?
17) What was the development of alternative sources of energy caused by in the 1990s?
18) What has helped wind power capacity grow substantially over the last 10 years?
19) What are the advantages of wind energy?
20) What are the disadvantages of wind machines?

38. Write a summary of Text D. Consult page 10.

Over to you

39. Discuss with your groupmates or in pairs:

1) What are the main problems with wind power usage in Belarus?
2) Is it possible to use energy from the wind for industrial purposes in our Republic? Why? Why not?
3) What European countries actively utilize wind energy? Give examples. (Find out additional information).

Language Focus

40. Fill in the gaps with the words from the text.

1) Wind farms are considered to be ... of wind machines used to produce ...
2) The types of wind machines are based on the direction of the rotating ...
3) Many power plants are ... by business people who sell the electricity from the wind farm to ...
4) Good sites for wind plants are the tops of ... hills and mountain ...
5) Wind speed increases with ...
6) Many utilities around the U.S. offer ... to the customer to support alternative ...
7) Germany ... first in the world in wind power ...
8) The most serious environmental ... to the wind machines are their negative effect on ...

41. Find the defined words in the text.

- The height of an object or structure above a reference level, usually above sea level or the Earth's surface.
- A fence or a line of trees that gives protection from the wind by breaking its force.
- A company that performs a public service; subject to government regulation.
- Energy or a substance given out by something.
- A tax deduction that is granted in order to encourage a particular type of commercial activity.

42. Fill in the correct prepositions, translate the phrases, then choose any five items and make up sentences of your own.

1) air ___ motion; 2) to be made ___ sth.; 3) land heats ___ more quickly; 4) air cools more rapidly ___ land; 5) ___ the same way; 6) the wind blows __ long ___ the sun shines; 7) ___ ancient times; 8) to be famous ___ sth.; 9) to slow ___ the speed of the wind; 10) to be connected __ sth.; 11) to be based __ the direction of the axis; 12) blades that go ___ top ___ bottom; 13) to make ___ a small percent; 14) to scatter ___ a large area; 15) to be owned ___ public utility companies; 16) ___ a rule; 17) to vary ___ season ___ season; 18) tax breaks ___ renewable energy; 19) to pay ___ electricity that comes ___ renewable sources; 20) ___ response ___.

43. Fill in the words listed below.

a) production	*e) fraction*
b) growing	*f) generated*
c) electricity	*g) year*
d) larger	*h) times*

In 2006, wind machines in the United States 1) _____ a total of 26,6 billion kWh per 2) _____ of electricity, enough to serve more than 2,4 million households. This is enough 3) _____ to power a city 4) _____ than Los Angeles, but it is only a small 5) _____ of the nation's total electricity 6) _____, about 0,4 percent. The amount of electricity generated from wind has been 7) _____ fast in recent years. In 2006, electricity generated from wind was 21/28) _____ more than wind generation in 2002. [9]

It's important to know

44. Translate the following text into Russian in written form paying attention to *-ing* forms.

Green pricing is an optional utility service that allows customers an opportunity to support a greater level of utility company investment in renewable energy technologies. Participating customers pay a premium (наценка, надбавка) on their electric bills to cover the incremental (постепенно увеличивающийся) cost of the additional renewable energy. To date, more than 850 utilities, including investor-owned, municipal utilities, and cooperatives, offer a green pricing option.

Active Vocabulary

45. Give Russian equivalents of the following words and phrases. Try to memorize them.

Nouns and noun phrases

elevation	water intake	penstock
demand	tailrace	conductor
current	loops	load
field poles	stator	adjustment
gravity	wicket gate	

Verbs and verbal phrases

to attach
to rotate

Reading Task: *Text E*

46. Answer the following question and read the text below to check your answer.

How do we get electricity from water?

Hydroelectric Power: How It Works

So just how do we get electricity from water? Actually, hydroelectric and coal-fired power plants produce electricity in a similar way. In both cases a power source is used to turn a propeller-like piece called a turbine, which then **turns** a metal shaft in an electric generetor, which is the motor that produces electricity. A coal-fired power plant uses steam to turn the turbine blades; whereas a hydroelectric plant uses falling water to turn the turbine. The results are the same (see Fig. 15).

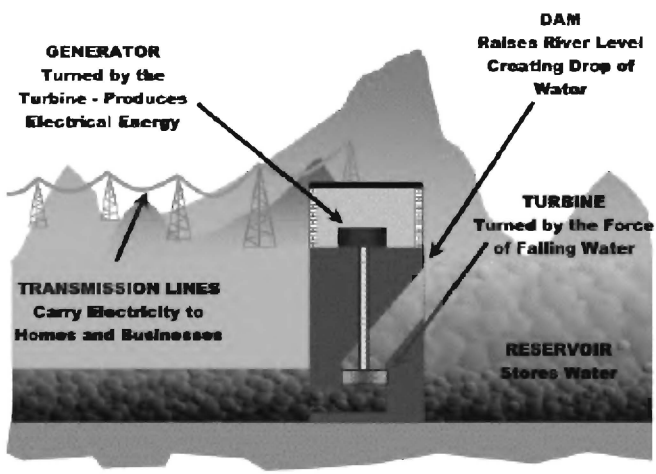


Fig. 15. How hydroelectric power works

The theory is to build a dam on a large river that has a large drop in elevation. The dam **stores** lots of water behind it in the reservoir. Near the bottom of the dam wall there is the water intake. **Gravity** causes it to fall through the penstock inside the dam. At the end of the penstock there is a turbine propeller, which is turned by the moving water. The shaft from the turbine goes up into the generator, which produces the power. Power lines are connected to the generator that carry electricity to your home. The water continues past the propeller through the tailrace into the river **past** the dam.

As to how this generator works, the Corps of Engineers explains it this way: "*A hydraulic turbine converts the energy of flowing water into mechanical energy. A hydroelectric generator converts this mechanical energy into electricity. The* ***operation*** *of a generator is based on the principles discovered by Faraday. He found that when a magnet is moved past a conductor, it causes electricity to flow. In a large generator, electromagnets are made by circulating direct current through loops of wire wound around stacks of magnetic steel laminations. These are called field poles, and are mounted on the perimeter of the rotor. The rotor is attached to the turbine shaft, and rotates at a fixed speed. When the rotor turns, it causes the field poles (the electromagnets) to move past the conductors mounted in the stator. This, in turn, causes electricity to flow and a voltage to develop at the generator output terminals* (see Fig. 16)."

Demand for electricity is not «flat» and constant. Demand goes up and down during the day, and overnight there is less need for electricity in homes, businesses, and other facilities. Hydroelectric plants are more efficient at providing for peak power demands during short periods than are fossil-fuel and nuclear power plants, and one way of doing that is by using «pumped storage», which reuses the same water more than once (see Fig. 17, 18).

Pumped storage is a method of keeping water in **reserve** for peak period power demands by pumping water that has already flowed through the turbines back up a storage pool above the power plant at a time when customer **demand** for energy is low, such as during the middle of the night. The water is then allowed to flow

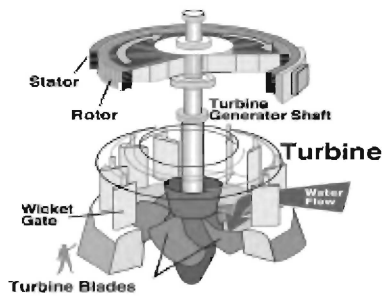


Fig. 16. Generator

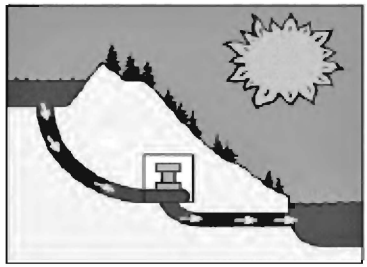


Fig. 17. Daytime: Water flows downhill through turbines, producing electricity

Fig. 18. Nightime: Water pumped uphill to reservoir for tomorrow's use

back through the turbine-generators at times when demand is high and a heavy load is placed on the system.

The reservoir **acts** much like a battery, storing power in the form of water when demands are low and producing maximum power during daily and seasonal peak periods. An advantage of pumped storage is that hydroelectric generating units are able to start up quickly and make rapid adjustments in output. They operate efficiently when used for one hour or several hours. Because pumped storage reservoirs are relatively small, construction costs are generally low compared with conventional hydropower facilities. [10]

Comprehension Check

47. Complete the following sentences according to the text.

1) Hydroelectric and coal-fired power plants produce electricity in … .
2) The theory is to build a dam on a large river that has … .
3) … causes water to fall through the penstock inside the dam.
4) There is less need for electricity in homes, businesses, and other facilities … .
5) Hydroelectric plants are more efficient at providing for peak power demands during short periods than are … .
6) An advantage of pumped storage is … .

48. Answer the following questions and give examples.

1) What does a coal-fired power plant use to turn the turbine blades?
2) What does a hydroelectric plant use to turn the turbine?

3) Where is the water intake?
4) What is a turbine propeller turned by?
5) Does the generator produce the power?
6) Is demand for electricity «flat» and constant? Why? Why not?
7) What is «pumped storage»?
8) Does the reservoir act much like a battery? Why? Why not?
9) Why are construction costs generally low compared with conventional hydropower facilities?

49. Translate the italicized passage in written form paying attention to Passive Voice.

50. Find key words and phrases which best express the general meaning of each paragraph.

51. Write a summary of Text E. Consult page 10.

Over to you

52. Discuss with your groupmates or in pairs:

1) Is it possible to use energy from water in our Republic? Why? Why not?
2) What European countries actively utilize hydroelectric power? Give examples. (Find out additional information).

Language Focus

53. Combine the words from the column on the left with the suitable nouns from the column on the right. Translate them into Russian.

1) similar	a) intake
2) metal	b) generator
3) water	c) way
4) turbine	d) shaft
5) hydroelectric	e) propeller
6) magnetic	f) load
7) field	g) poles
8) fixed	h) power demand
9) peak period	i) storage

10) heavy	j) adjustment
11) pumped	k) steel laminations
12) rapid	l) hydropower facilities
13) conventional	m) speed

54. Choose the contextual meanings of the words written in bold in Text E.

1. **turns**
   a) поворачивать
   b) вращаться
   c) очередь
   d) оборот
2. **stores**
   a) запас
   b) снабжать
   c) накапливать
   d) резерв
3. **gravity**
   a) сила тяжести
   b) плотность
   c) течь самотеком
   d) серьезность
4. **past**
   a) прошлый
   b) по ту сторону
   c) истекший
   d) мимо
5. **operation**
   a) управление
   b) процесс
   c) действие
   d) операция
6. **reserve**
   a) запасать
   b) запас, резерв
   c) запасной
   d) предназначать
7. **demand**
   a) нагрузка
   b) спрос
   c) требовать
   d) нуждаться
8. **acts**
   a) действие
   b) влиять
   c) работать
   d) представлять

55. Form the nouns from the following verbs.

to generate →…	to turn →…	to adjust →…
to elevate →…	to demand →…	to store →…
to conduct →…	to facilitate →…	to move →…

56. Form the verbs from the following nouns.

connection →…	explanation →…	conversion →…
attachment →…	rotation →…	allowance →…
operation →…	comparison →…	circulation →…

57. Fill in the correct prepositions, translate the phrases, then choose any five items and make up sentences of your own.

1) ___ a similar way; 2) ___both cases; 3) a drop ___ elevation; 4) to fall ___ the penstock; 5) the shaft ___ the turbine; 6) the shaft goes up ___ the generator; 7) to be connected ___ the generator; 8) to carry electricity ___ one's home; 9) to convert the energy of flowing water ___ mechanical energy; 10) to be mounted ___ the perimeter of the rotor; 11) need ___ electricity; 12) to flow ___ the turbines back ___ a storage pool ___ the power plant; 13) to place load ___ the system; 14) to start ___ quickly; 15) to compare ___ sth.

Active Vocabulary

58. Give Russian equivalents of the following words and phrases. Try to memorize them.

Nouns and noun phrases		
blend	carbon dioxide	sulfur dioxide
particulates	nitrogen oxides	auto ignition
engine torque	mitigation	feedstock
exhaust odor	flashpoint	
Verbs and verbal phrases		**Adjectives**
to blend		lubricating

59. Translate abbreviations.

EPA (Environmental Protection Agency) – _____
CBO (Congressional Budget Office) – _____
USDA (Department of Agriculture) – _____
USDD (Department of Defense) – _____

Reading Task: *Text F*

60. Read the first paragraph of Text F and answer the questions.

1) What is biodiesel?
2) Who developed the first diesel engine? When?

61. The rest of the text "What is Biodiesel?" is in the jumbled order. Look at the plan of the text, read the parts and number them in the correct order according to the plan.

Plan:

1. Properties of Biodiesel.
2. Advantages of Biodiesel.
3. Biodiesel Impact.

What is Biodiesel?

Biodiesel is the name for a variety of ester-based oxygenated fuels made from Hemp oil, other vegetable oils or animal fats. The concept of using vegetable oil as an engine fuel dates back to 1895 when Dr. Rudolf Diesel developed the first diesel engine to run on vegetable oil. Diesel demonstrated his engine at the World Exhibition in Paris in 1900 using peanut oil as fuel.

□ An important factor that is not usually considered when calculating the costs and benefits of industrial feedstock materials is the macroeconomic effect associated with domestically produced, renewable energy sources. Economic benefits of a biodiesel industry in the US would include value added to the feedstock (oilseeds or animal fats), an increased number of manufacturing jobs, an increased tax base from plant operations and income taxes, investments in plant and equipment, improvement of trade balance, and reductions in health care costs due to improved air quality and greenhouse gas mitigation.

Biodiesel has positive impacts on the state economy. An Iowa State University study concluded that three economic benefits would accrue to state from biodiesel. First, biodiesel expands demand for soybean oil, causing processors to pay more for soybeans. In addition, soybean farmers near the biodiesel plant would receive slightly higher prices for soybeans; and third, the presence of a facility that creates energy from soybeans would add value to the state's industrial and income base.

Dr. Hayes concluded that, "If the state of Iowa were to mandate the use of a 20% biodiesel blend in its state vehicle fleet where feasible, the total additional cost of this policy would range from $400,000 to $500,000. If it could be shown that this policy would result in a new five million gallon biodiesel plant in the state, then the policy would create more new tax revenues than it would cost and would clearly be in the best interest of the state."

Biodiesel has positive implications for production agriculture. A 1996 economic study published by the USDA Office of Energy predicted that a modest, sustained annual market for biodiesel of 100 million gallons in the US would contribute approximately seven cents to the price of each bushel of soybeans produced in the US. Based on last year's harvested crop, the increase could have resulted in more than $168 million directly to the use of biodiesel.

Biodiesel has a positive impact on the world balance of trade. A 1998 biodiesel lifecycle study jointly sponsored by the US Department of Energy and the European Department of Agriculture concluded that increased use of biodiesel and biodiesel blended fuels such as B20 would substantially benefit the world economy. The report concluded that national spending to import petroleum sends significant amounts of dollars out of our domestic economy every year.

Biodiesel offers the potential to shift this spending from foreign imports to domestically produced energy. The report notes: "With its ability to be used directly in existing diesel engines, biodiesel offers the immediate potential to reduce our demand for petroleum in the transportation sector."

Biodiesel contributes jobs to the local economy. Economic work conducted at the University of Missouri estimated the benefits of producing biodiesel in a metropolitan region. This study concluded that 100 million gallons of biodiesel production could generate an estimated $8,34 million increase in personal income and over 6,000 additional temporary or permanent jobs for the metropolitan region.

□ Today's diesel engines require a clean-burning, stable fuel that performs well under a variety of operating conditions. Biodiesel is the only alternative fuel that can be used directly in any existing, unmodified diesel engine. Because it has similar properties to petroleum diesel fuel, biodiesel can be blended in any ratio with petroleum diesel fuel. Many federal and state fleet vehicles are already using biodiesel blends in their existing diesel engines.

The low emissions of biodiesel make it an ideal fuel for use in marine areas, national parks and forests, and heavily polluted cities. Biodiesel has many advantages as a transport fuel. For example, biodiesel can be produced from domestically grown oilseed plants such as Hemp.

□ Biodiesel is the only alternative fuel that runs in any conventional, unmodified diesel engine. It can be stored anywhere that petroleum diesel fuel is stored.

Biodiesel can be used alone or mixed in any ratio with petroleum diesel fuel. The most common blend is a mix of 20% biodiesel with 80% petroleum diesel, or "B20."

The lifecycle production and use of biodiesel produces approximately 80% less carbon dioxide emissions, and almost 100% less sulfur dioxide. Combustion of biodiesel alone provides over a 90% reduction in total unburned hydrocarbons, and a 75–90% reduction in aromatic hydrocarbons. Biodiesel further provides significant reductions in particulates and carbon monoxide than petroleum diesel fuel. Biodiesel provides a slight increase or decrease in nitrogen oxides depending on engine family and testing procedures. Based on Ames Mutagenicity tests, biodiesel provides a 90% reduction in cancer risks.

Biodiesel is 11% oxygen by weight and contains no sulfur. The use of biodiesel can extend the life of diesel engines because it is more lubricating than petroleum diesel fuel, while fuel consumption, auto ignition, power output, and engine torque are relatively unaffected by biodiesel.

Biodiesel is safe to handle and transport because it is as biodegradable as sugar, 10 times less toxic than table salt, and has a high flashpoint of about 300 F compared to petroleum diesel fuel, which has a flash point of 125 F.

Biodiesel can be made from domestically produced, renewable oilseed crops such as Hemp.

Biodiesel is a proven fuel with over 30 million successful US road miles, and over 20 years of use in Europe.

When burned in a diesel engine, biodiesel replaces the exhaust odor of petroleum diesel with the pleasant smell of Hemp, popcorn or french fries.

The Congressional Budget Office, Department of Defense, US Department of Agriculture, and others have determined that biodiesel is the low cost alternative fuel option for fleets to meet requirements of the Energy Policy Act. [14]

Comprehension Check

62. Complete the following sentences according to the text.

1) Biodiesel is …
2) Dr. Rudolf Diesel developed the first diesel engine …
3) His engine was demonstrated …
4) Today's diesel engines require …
5) Biodiesel can be blended in any ratio with …
6) The low emissions of biodiesel make it an ideal fuel for use in …
7) The most common blend is a mix of …
8) The lifecycle production and use of biodiesel produces …
9) Biodiesel further provides significant reductions …
10) The use of biodiesel can extend …
11) Biodiesel is safe to handle and transport because …
12) Biodiesel can be made from …
13) The Congressional Budget Office, Department of Defense, US Department of Agriculture, and others have determined that …
14) Economic benefits of a biodiesel industry would include …

63. Answer the following questions and give examples.

1) What are the main properties of Biodiesel?
2) How many advantages of Biodiesel were mentioned in the text?
3) What is the macroeconomic effect of Biodiesel?
4) What implications for production agriculture does Biodiesel have?
5) What is its impact on the world balance of trade?
6) Is Dr. Hayes' conclusion positive or negative? Why? Why not?
7) Was the article written by an American or by a citizen of another country? Why do you think so?

64. Fill in the table according to the Text F.

Properties of Biodiesel	Advantages of Biodiesel	Biodiesel Impact
perform well; can be used in any diesel engine; …; …; …	…; …	…; …

65. Find key words and phrases which best express the general meaning of each paragraph.

66. Make an oral report on Text F. Consult pages 29-30.

Over to you

67. Discuss with your groupmates or in pairs:

1) What plants can be used for biomass production in our Republic?
2) Would you fuel your vehicle with biofuel? Why? Why not?

Language Focus

68. Match the English and Russian equivalents.

1) operating conditions	a) условия эксплуатации
2) in any ratio	b) прибрежные области
3) marine areas	c) тщательное исследование
4) agricultural revenue	d) в любых пропорциях
5) thorough inventory	e) промышленное сырье
6) cancer risk	f) основа дохода
7) industrial feedstock	g) транспортное хозяйство
8) significant reduction	h) риск раковых заболеваний
9) income base	i) значительное снижение
10) transportation sector	j) государственные доходы от сельского хозяйства

69. Fill in the table with the derivatives.

Noun	Verb	Adjective
1)	to blend	
2) emission		
3)		extended
4) combustion		
5)	to reduce	
6)		sustainable
7)	to contribute	
8) value		

70. Match the synonyms.

1) to develop	a) to show
2) to demonstrate	b) to invent
3) to perform	c) to obtain
4) to blend	d) to operate
5) advantage	e) to calculate
6) conventional	f) to forecast
7) revenue	g) to mix
8) receive	h) to income
9) to reduce	i) to accumulate
10) to store	j) to shorten
11) to predict	k) benefit
12) to estimate	l) standard

71. Match the opposites.

1) blend	a) considerable
2) domestic	b) foreign
3) temporary	c) doubted
4) import	d) separate
5) immediate	e) decrease
6) safe	f) distant
7) slight	g) permanent
8) increase	h) exclude
9) proven	i) export
10) include	j) dangerous

Language Development

72. Fill in the gaps with the omitted words.

a) visual	*f) difficult*	*k) blades*
b) speeds	*g) operational*	*l) windy*
c) withstand	*h) harnessing*	*m) grid*
d) duration	*i) marine*	*n) CO_2*
e) renewable	*j) offshore*	

The use of wind as a 1) _____ energy source involves the 2) _____ of power contained in moving air. There are currently over 1000 wind turbines connected to the 3) _____, producing 0.4% of the UK's power, preventing the emission of over one mil-

lion tonnes of 4) _____ a year. Although the majority of wind farm sites are currently located on land, the positioning of such developments is 5) _____, as they need to be in 6) _____ areas such as hills and open countryside, but are often considered to be unacceptable in terms of 7) _____ impact. In order to allow the continued development of the industry, a series of offshore wind farms are now being developed. There are some frequently asked questions: *What if there's a storm at sea?* 8)_____ turbines are warranted and tested to 9) _____ extreme wind conditions. In the event of severe weather, the 10) _____ turn out of the wind and will slow down for safety reasons when wind 11) _____ reach 50 miles per hour and above. *Will they affect marine life?* There are three significant stages of a wind farm from the point of view of 12) _____ life: construction, operation and decommissioning. Construction and decommissioning have the potential to generate the most amount of disturbance. However, it should be noted that the 13) _____ of the construction and decommissioning will be about 6 months only. For the 20-year 14) _____ period there are no known impacts on marine life. [14]

73. Translate the sentences from Russian into English.

А. Начиная с 1970-х гг., передовые проекты аэродинамики использовались для построения ветряных турбин, которые производят электричество. Самая крупная из них, построенная на Гавайях, имеет два крыла, каждое по 50 м в длину, прикрепленных к высокой 20-этажной башне. Отдельные турбины часто сгруппированы в стратегически важных местах (ветряные фермы), чтобы максимально увеличить производственный потенциал. Энергия ветра – дешевый способ получения возобновляемой энергии, но пока что он не может производить достаточное количество электричества для обеспечения реальной альтернативы топливным и атомным электростанциям.

Б. Генератор – устройство, вырабатывающее энергию путем преобразования энергии турбин или двигателя внутреннего сгорания в электричество, используя электромагнитную индукцию. Существует два типа генераторов: переменного и постоянного тока. Каждый из них имеет вращающуюся часть, что приводит к появлению в магнитном поле электрического тока.

В. Гидроэлектроэнергия – электричество, получаемое в результате движения воды. С помощью оборудования энергия движения (или кинетическая энергия), сначала превращается

в механическую во вращающихся лопастях водяной турбины, затем – в электричество посредством ротора генератора. Многие электростанции приводятся в движение водой, выпускаемой из шлюзов плотин для регулирования водного потока.

Г. Турбина – устройство, которое вращается с помощью движущейся жидкости или газа. Современный вариант водной турбины – это многолопастный пропеллер, который используется для выработки гидроэлектричества. В электростанциях, которые для производства электричества сжигают топливо, энергия, вырабатываемая при сгорании, приводит во вращение лопасти реактивных паровых турбин. Вращаясь, турбины приводят в движение генераторы, которые и производят электричество. Ветряные генераторы вырабатывают электричество, когда ветер вращает роторы.

Д. Биомасса – один из старейших источников энергии. Однако до недавнего времени его использовали лишь для непосредственного сжигания на открытой местности или в печах. Таким образом, результативность была очень низкой. Позже большее внимание стали уделять эффективности использования биомассы для энергетических целей. Основными преимуществами этого возобновляемого источника являются: использование растительной биомассы, которая постоянно возобновляется; энергетическое использование отходов частично решает проблемы, связанные с загрязнением окружающей среды; новейшие технологии позволяют сделать использование биомассы наиболее эффективным.

Е. Геотермальная энергия – запасы глубинного тепла Земли. Образуется в результате радиоактивности коры Земли и движения тектонических плит. Выходит на поверхность во время извержения вулканов. Гейзеры – также одно из проявлений вулканизма. Может быть использована как источник энергии для производства электричества.

Follow Up

74. Read the texts of Unit IV again and make notes under the following headings. Then use your notes to talk about *Alternative Sources of Energy*. You may add your topic with extra information about alternative sources of energy.

1. A difference between renewable and non-renewable energy sources.

2. It is important to develop alternative energy sources.
3. How Solar Energy works.
4. Energy from Wind.
5. Hydroelectric Power: how it works.
6. What is Biodiesel and its advantages.

REVIEW

Check Your Knowledge

1. Here's a quiz to test your energy knowledge.

1. Most of the energy we use originally came from …
   a) the sun *c) the soil*
   b) the air *d) the oceans*
2. Electrical energy can be produced from …
   a) mechanical energy *c) radiant energy*
   b) chemical energy *d) all of the above*
3. Which uses the most energy in American homes each year?
   a) lighting *c) heating and cooling rooms*
   b) water heating *d) refrigeration*
4. The U.S. consumes lots of energy. Which fuel provides the most energy?
   a) petroleum *c) natural gas*
   b) coal *d) solar*
5. Coal, petroleum, natural gas, and propane are fossil fuels. They are called fossil fuels because: …
   a) they are burned to release energy and they cause air pollution;
   b) they were formed from the buried remains of plants and tiny animals that lived hundred of millions of years ago;
   c) they are nonrenewable and will run out;
   d) they are mixed with fossils to provide energy.
6. Which fossil fuel is refined to produce gasoline?
   a) natural gas *c) petroleum*
   b) coal *d) propane*
7. Propane is used instead of natural gas on many farms and in rural areas. Why is propane often used instead of natural gas?
   a) it's safer *c) it's cleaner*
   b) it's portable *d) it's cheaper*

8. Natural gas is transported mainly by …

a) pipelines *c) barges*
b) trucks *d) all three equally*

9. Which gas in the atmosphere causes global warming?

a) ozone *c) carbon dioxide*
b) sulfur dioxide *d) nitrous oxide*

10. Solar, biomass, geothermal, wind, and hydropower energy are all renewable sources of energy. They are called renewable because they …

a) are clean and free to use;
b) can be converted directly into heat and electricity;
c) can be replenished by nature in a short period of time;
d) do not produce air pollution.

11. Today, which renewable energy source provides the world with the most energy?

a) wind *c) geothermal*
b) solar *d) hydropower*

12. Electricity is the movement of …

a) atoms *c) electrical power*
b) molecules *d) neutrons*

13. In a nuclear power plant, uranium atoms …

a) combine and give off heat energy;
b) split and give off heat energy;
c) burn and give off heat energy;
d) split and give off electrons.

2. Translate these phrases into English.

A. Запускать генераторы, акватические отходы, ограниченное количество, основной источник энергии, большие участки земли, аккумулирующая способность, энергия солнца, воспользоваться преимуществом, широко доступный, производить непосредственно, поверхность Земли, при надлежащем проектировании, активно накапливать и сохранять, нагретая жидкость, водно-спиртовой раствор, предотвращать замораживание, значительный рост, традиционные системы, государственные доходы от сельского хозяйства, тщательное исследование, промышленное сырье, транспортное хозяйство,

значительное снижение, условия эксплуатации, энергия ветра, составлять небольшой процент.

Б. Ветряная мельница – механизм, приводимый в движение ветром, действующим на паруса или лопасти. Самые ранние ветряные мельницы появились на Ближнем Востоке в VII веке.

3. Study the diagram (see Fig. 19). It shows one method of converting wave energy into electrical power. Decide how it works and make Task 4.

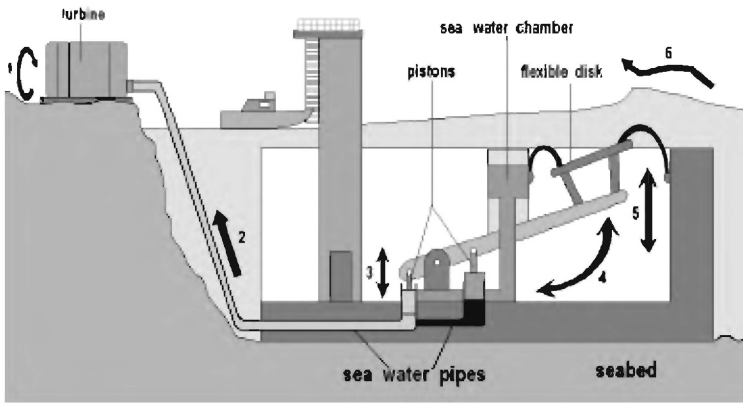


Fig. 19. Converting wave energy into electrical hower

4. Read the following presentation and fill it in with the words listed below.

a) seabed	*d) rotates*	*g) high*
b) chamber	*e) renewable*	*h) turbine*
c) down	*f) energy*	*i) pistons*

Wave Energy Converter

Definition: system for converting (1) _____ from sea waves into electrical power

Location: fixed to the (2) _____

Main components: a flexible disk, a (3) _____ which takes in sea water, a set of (4) _____, many sea water pipes, a (5) _____ on the land

Operation: wave oscillates → pushes disc (6) _____ → lever oscillates → reciprocating pumps push water through pipe at

(7) _____ → lever oscillates pressure → turbine (8) _____ → generates electricity

Benefits: Wave energy is a (9) _____ energy resource; uses no fossil fuels [1]

5. Translate the text into Russian in written form.

Different Natural Sources of Energy

We all know that the earth has limited stock of non-renewable sources of energy like coal and oil. On the other hand, renewable energy sources like solar energy, wind energy, bio-gas is available in unlimited quantities and can thus, help us solve the energy crisis that might arise in the future.

Alternative sources of energy are a key towards future power generation. With the increasing green house emission rates and with ever growing global warming, it is now the responsibility of every citizen and the government to deal with the energy problems seriously. Alternative energy sources help in energy production.Solar power generators are even capable of meeting our transportation needs. Wind and hydro power can be used to run machines and thus, generate electricity. [6]

NUCLEAR POWER

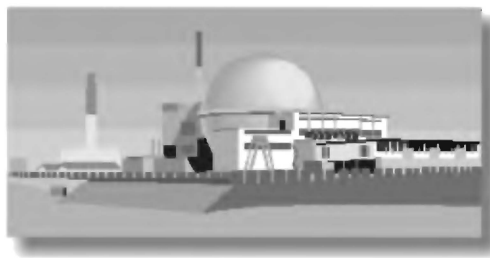


Fig. 20. Nuclear power station [11]

Start here

1. Choose the right word.

1) Nuclear power is *(reduced / generated / increased)* using Uranium, which is a metal mined in various *(parts / kinds / stages)* of the world.
2) The first large-scale nuclear power station *(demolished / closed / opened)* at Calder Hall in Cumbria, England, in 1956.
3) Some *(cargo / civil / military)* ships and submarines have nuclear power plants for *(chambers / engines / fission)*.
4) *(Metal / Concrete)* plays an important role in containing *(nuclear / radioactive)* materials.

2. Join the blocks in the right order.

nuclear fission makes heat	**steam turns turbines**	**electrical power sent around country**
heat water to make steam	**turbines turn generators**	

Active Vocabulary

3. Give Russian equivalents of the following words and phrases. Try to memorize them.

Nouns and noun phrases

coolant	torrent
image	coal-burning

Verbs and verbal phrases

to flicker	to praise
to invoke	to emit

Adjectives	**Adverbs**
impressive	overall
cosmic	

Reading Task: *Text A*

4. Answer the following question and read the text below to check your answer.

Why can nuclear power be considered as an alternative to fossil fuels?

When you hear the words "nuclear power", different images may flicker through your mind: concrete coolant towers emitting torrents of steam (Fig. 21) or a mushroom cloud rising high into the sky.

Some people praise the technology as a low-cost, low-emission alternative to fossil fuels, while others stress the negative impact of nuclear waste and accidents such as Three Mile Island and Chernobyl. There's a lot of discussion out there about nuclear power's role in our lives, but what's going on at the heart of these power plants?

Fig. 21.

As of July 2008, there were more than 430 operating nuclear power plants and, together, they provided about 15 percent of the

world's electricity in 2007. Of these 31 countries, some depend more on nuclear power than others. For instance, in France about 77 percent of the country's electricity comes from nuclear power. Lithuania comes in second, with an impressive 65 percent. In the United States, 104 nuclear power plants supply 20 percent of the electricity overall, with some states benefiting more than others.

Despite all the cosmic energy that the word "nuclear" invokes, power plants that depend on atomic energy don't operate that differently from a typical coal-burning power plant. Both heat water into pressurized steam, which drives a turbine generator. The key difference between the two plants is the method of heating the water. While older plants burn fossil fuels, nuclear plants depend on the heat that occurs during nuclear fission, when one atom splits into two. [11]

Comprehension Check

5. Answer the following questions and give examples.

1) What are people's opinions related to nuclear power?
2) What accidents make them feel negative?
3) How many countries depend on nuclear power?
4) What do statistics of 2008 show?
5) What countries depend on nuclear power more than others?
6) What is the same about nuclear power and coal-burning power plants?
7) What is the key difference between them?
8) What is fission?
9) When you hear the words "nuclear power", what do you imagine?
10) Is there any difference between words "nuclear" and "atomic"?

6. Decide whether the following statements are true or false according to the text.

1) The technology of nuclear power is a low-cost, low-emission alternative to fossil fuels.
2) It doesn't produce any negative impact.
3) According to data of July 2008, there were more than 430 operating nuclear power plants.
4) They provided more than 15 percent of the world's electricity in 2008.

5) In France about 77 percent of the country's electricity comes from nuclear power.
6) In Baltic republics nuclear power plants supply 65 percent of the electricity overall.
7) In the United States some states benefit more than others.
8) Power plants that depend on atomic energy don't operate that differently from a typical fuel-burning power plant.
9) Coal-burning power plant heats water into pressurized steam, which drives a turbine generator.
10) Nuclear plants depend on the heat that occurs during nuclear fusion.

7. Write a summary of Text A. Consult page 10.

Over to you

8. Discuss with your groupmates or in pairs:

1) What are the consequences of the explosion at the Chernobyl nuclear power station in 1986 for Belarus?
2) Is it safe to live on the territory of Belarus currently? Why? Why not? (Find out additional information).

Language Focus

9. Match the English and Russian equivalents.

a) to flicker through one's mind	1) извлекать пользы больше остальных
b) concrete coolant towers	2) главное отличие
c) torrents of steam	3) грибовидное облако
d) a mushroom cloud	4) грандиозная энергия
e) to praise the technology	5) промелькнуть в голове
f) to benefit more than others	6) пар под давлением
g) cosmic energy	7) потоки пара
h) pressurized steam	8) турбогенератор
i) the key difference	9) превозносить технологию
j) a turbine generator	10) бетонные охладительные башни

10. Match the terms with their definitions.

a) power	*e) fusion*
b) alternative	*f) negative*
c) waste	*g) turbine*
d) fission	*h) generator*

1) the act or process of fusing or melting together;
2) any of various types of machine in which the kinetic energy of a moving fluid is converted into mechanical energy by causing a bladed rotor to rotate;
3) a measure of the rate of doing work expressed as the work done per unit time. It is measured in watts, horsepower, etc;
4) any device for converting mechanical energy into electrical energy by electromagnetic induction, esp a large one as in a power station;
5) anything rejected as useless, worthless, or in excess of what is required;
6) a possibility of choice, esp between two things, courses of action, etc;
7) the act or process of splitting or breaking into parts;
8) lacking positive or affirmative qualities.

It's important to know

11. Translate the text into Russian in written form paying attention to active vocabulary.

What is a Difference Between Atomic and Nuclear Energy?

Nuclear energy or atomic energy is the type of energy that comes from the nuclei of atoms. Both protons (positive electric charge) and neutrons (neutral) are found in the nucleus of an atom. The nucleus contains most of the mass of an atom. Energy is released any time there is a change in an atom's nucleus.

But "atomic energy" is really a misnomer for nuclear energy. It is the fission of the nucleus which causes energy to be released. At the atomic level we are dealing with chemical reactions, but in the early days people did talk of atomic power and atomic bombs.

Active Vocabulary

12. Give Russian equivalents of the following words and phrases. Try to memorize them.

Nouns and noun phrases

half-life	lead	chain
photon	capturing	equation $E = mc^2$

Verbs and verbal phrases **Adjectives**

to undergo	enriched
to eject	handy
	induced

13. Read the following international words and mind the stressed syllables.

uranium	neutron	million electron volts
percent	proton	gamma radiation
isotope	spontaneous	beta radiation
alpha radiation	picoseconds	plutonium

Reading Task: *Text B*

14. Answer the following question and read the text below to check your answer.

What is the difference between fission and fusion?

Nuclear Fission

Everyone from comic book writers to theoretical physicists have characterized the splitting of the atom as the ultimate act of man playing God, so it's easy to forget that nuclear fission happens naturally every day. Uranium, for example, constantly undergoes spontaneous fission very slowly. This is why the element emits radiation, and why it's a natural choice for the induced fission that nuclear power plants require.

Uranium is a common element on the Earth. It's been around since the planet formed. Uranium-238 (U-238) has an extremely long half-life (the time it takes for half its atoms to decay) of 4,5 billion years. Therefore, it's still present in fairly large quantities. U-238 makes up 99 percent of the uranium on Earth, while urani-

um-235 (U-235) makes up about 0,7 percent of the remaining uranium found naturally. Uranium-234 is even rarer, formed by the decay of U-238. U-238 goes through many stages of decay in its life span, eventually forming a stable isotope of lead, so U-234 is just one link in that chain.

Uranium-235 has an interesting property that makes it handy for the production of both nuclear power and nuclear bombs. U-235 decays naturally, just as U-238 does, by alpha radiation: it throws off an alpha particle, or two neutrons and two protons bound together. U-235 also undergoes spontaneous fission a small percentage of the time. However, U-235 is one of the few materials that can undergo induced fission. If a free neutron runs into a U-235 nucleus, the nucleus will absorb the neutron, become unstable and split immediately.

As soon as the nucleus captures the neutron, it splits into two lighter atoms and throws off two or three new neutrons (the number of ejected neutrons depends on how the U-235 atom splits). The process of capturing the neutron and splitting happens very quickly, on the order of picoseconds ($1x10^{-12}$ seconds).

The decay of a single U-235 atom releases approximately 200 MeV (million electron volts). That may not seem like much, but there are a lot of uranium atoms in a pound (0,45 kg) of uranium. So many, in fact, that a pound of highly enriched uranium as used to power a nuclear submarine is equal to about a million gallons of gasoline.

The splitting of an atom releases an incredible amount of heat and gamma radiation, or radiation made of high-energy photons. The two atoms that result from the fission later release beta radiation (super fast electrons) and gamma radiation of their own as well. The energy released by a single fission comes from the fact that the fission products and the neutrons, together, weigh less than the original U-235 atom. The difference in weight is converted directly to energy at a rate governed by the equation $E = mc^2$.

However, for all of this to work, a sample of uranium must be enriched so that it contains 2 to 3 percent more U-235. Three-percent enrichment is sufficient for nuclear power plants, but weapons-grade uranium is composed of at least 90 percent U-235. [11]

What about plutonium?

Uranium-235 isn't the only possible fuel for a power plant. Another fissionable material is plutonium-239. Plutonium-239 is created by bombarding U-238 with neutrons, a common occurrence in a nuclear reactor.

Comprehension Check

15. Complete the following sentences according to the text.

1) Uranium constantly undergoes... .
2) U-238 has an extremely long half-life of ... .
3) U-238 makes up ... of the uranium on Earth.
4) U-235 is one of the few materials that ... .
5) As soon as the nucleus captures the neutron, it ... .
6) The decay of a single U-235 atom releases ... .
7) A pound of highly enriched uranium is equal to ... .
8) The splitting of an atom releases ... .
9) The two atoms that result from the fission later release ... .
10) The energy released by a single fission comes from the fact that ... .

16. Answer the following questions and give examples.

1) What is a half-life of U-238?
2) What is the share of U-238 of the uranium on Earth?
3) What is the share of U-235?
4) What makes U-238 handy for the production of nuclear power and nuclear bombs?
5) How quickly does the process of capturing the neutron and splitting happen?
6) How many volts does the decay of a single U-238 atom release?
7) What does the splitting of an atom release?
8) A sample of uranium has to be enriched so that it contains 2 to 3 percent more U-235 to work, hasn't it? Why? Why not?
9) Is U-235 the only possible fuel for a power plant? Why? Why not?
10) What is the other fissionable material?

17. Find key words and phrases which best express the general meaning of each paragraph.

18. Write down an abstract of Text B in 1-2 sentences. Consult page 14.

Over to you

19. Describe the process of nuclear fission using the picture below (see Fig. 22).

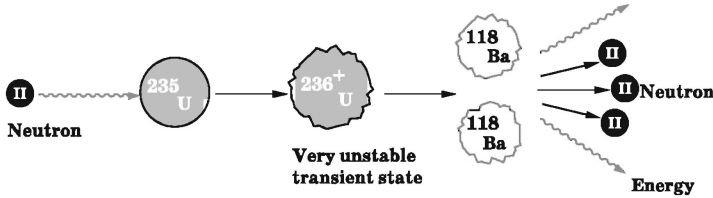


Fig. 22. Nuclear fission process

Language Focus

20. Fill in the correct prepositions, then translate phrases into Russian.

1) to be formed … the decay; 2) to go … many stages; 3) to split …; 4) … fact; 5) to be equal …; 6) amount … heat; 7) to come … the fact; 8) the difference … weight; 9) to convert … a rate; 10) to be composed … .

21. Translate these phrases into English using words from the box below. Think of the contextual meaning of the words.

at a rate, to throw off, as well, at least, to be around, to go through, to run into, to make up, on the order of, therefore

1) находиться, 2) по этой причине, 3) составлять, 4) проходить, 5) выделять, 6) сталкиваться, 7) приблизительно, 8) также, 9) с показателем, 10) по крайней мере.

22. Combine the words from the column on the left with the suitable nouns from the column on the right.

1) theoretical	a) occurrence
2) to emit	b) material
3) large	c) plant
4) ejected	d) physicists
5) fission	e) quantities
6) power	f) neutrons
7) fissionable	g) physicists
8) common	h) radiation

Active Vocabulary

23. Give Russian equivalents of the following words and phrases. Try to memorize them.

Nouns and noun phrases

criticality	kernels	enrichment
subcriticality	reactor core	ounce
supercriticality	control rods	

Verbs and verbal phrases

to collide
to hit

Adjectives	**Adverbs**
freewheeling	sequentially

Reading Task: *Text C*

24. Answer the following question and read the text below to check your answer.

What do you think is more dangerous: subcriticality or supercriticality?

Subcriticality, Criticality and Supercriticality

When a U-235 atom splits, two or three neutrons fly off. If there are no other U-235 atoms around, then those free neutrons fly into space as **neutron rays**. However, if the U-235 atom is part of a mass of uranium, then there are plenty of other U-235 atoms nearby for the freewheeling neutrons to collide with. Will one or more of the free neutrons hit another U-235 atom? The answer to that question determines a nuclear reactor's status.

Critical mass: If, on average, exactly one of the free neutrons from each fission hits another U-235 nucleus and causes it to split, then the mass of uranium is said to be critical. The mass will exist at a stable temperature.

Subcritical mass: If, on average, less than one of the free neutrons hits another U-235 atom, then the mass is subcritical. Eventually, induced fission will end under these conditions and your source of power along with it.

Supercritical mass: If, on average, more than one of the free neutrons hits another U-235 atom, then the mass is supercritical. This will cause the reactor to heat up.

In designing a nuclear bomb, engineers need the mass of uranium to be very supercritical so that all of the U-235 atoms in the mass split in a single microsecond. Think of it as all the kernels in a bag of popcorn popping at once, as opposed to sequentially.

In a nuclear reactor, however, the last thing you (and the rest of the world) want is all your atoms splitting at once. But the reactor core needs to be slightly supercritical so that plant operators can raise and lower the temperature of the reactor. The control rods give the operators a way to absorb free neutrons so operators can maintain the reactor at a critical level.

How do engineers control the criticality of the uranium? The amount of U-235 in the mass (the level of enrichment) plays a role, as does the shape of the mass itself. If the shape of the mass is a very thin sheet, most of the free neutrons will fly off into space rather than hitting other U-235 atoms. As such, a sphere is the optimal shape, and you'd need 2 pounds (0,9 kg) of uranium-235 in it to achieve a critical reaction. This amount is therefore referred to as the critical mass. For P-239, the critical mass is about 10 ounces (283 grams). [11]

Comprehension Check

25. Decide whether the following statements are true or false according to the text.

1) Two or three neutrons fly off when a U-235 atom splits.
2) Critical mass of uranium exists at a stable temperature.
3) If less than one of the free neutrons hits another U-235 atom, then the mass is supercritical.
4) Supercritical mass will cause the reactor to cool down.
5) In a nuclear bomb, the mass of uranium is to be supercritical.
6) In a nuclear reactor atoms are splitting at once.
7) The control rods give the operators a way to distribute free neutrons.
8) The shape of the mass itself plays a role to control the criticality of the uranium.
9) A cylinder is the optimal shape.
10) 2 pounds of uranium-235 is referred to as the **critical mass**.

26. Answer the following questions and give examples.

1) What happens when a U-235 atom splits?
2) What happens if there are no other U-235 atoms around?
3) What happens if the U-235 atom is a part of a mass of uranium?
4) What is "critical mass"?
5) What is "subcritical mass"?
6) What is "supercritical mass"?
7) What do engineers need in designing a nuclear bomb?
8) Why does the reactor core need to be slightly supercritical?
9) How do engineers control the criticality of the uranium?
10) What is "the critical mass"?

27. What parts of the text can you define? Do they correspond to the paragraphs? Name each part.

1. _____ 4. _____
2. _____ 5. _____
3. _____ … _____

28. Find key words and phrases which best express the general meaning of each part.

29. Make an oral report on Text C. Consult pages 29–30.

Language Focus

30. Fill in the table with appropriate derivatives.

Critical, criticality, nucleus, nuclear, neutron, collide, exactly, nearby, uranium, optimal, eventually, hit, reactor, split, raise.

Noun	Verb	Adjective	Adverb
…	…	…	…

31. Match the terms with their definitions.

a) ion
b) proton
c) absorber
d) nucleon
e) nuclear reactor
f) nucleus
g) stable
h) atom

1) a particle of matter indivisible by chemical means. It is the fundamental building block of elements;
2) any material that stops ionizing radiation. Lead, concrete, and steel attenuate gamma rays. A thin sheet of paper or metal will stop or absorb alpha particles and most beta particles;
3) a device in which a fission chain reaction can be initiated, maintained, and controlled. Its essential components are fissionable fuel, moderator, shielding, control rods, and coolant;
4) a constituent of the nucleus; that is, a proton or a neutron;
5) the core of the atom, where most of its mass and all of its positive charge is concentrated. Except for hydrogen, it consists of protons and neutrons;
6) non-radioactive;
7) one of the basic particles which makes up an atom. The proton is found in the nucleus and has a positive electrical charge equivalent to the negative charge of an electron and a mass similar to that of a neutron: a hydrogen nucleus;
8) an atomic particle that is electrically charged, either negative or positive.

It's important to know

32. Read the following text and fill in the missing words from the list below.

a) split	*g) reaction*
b) radioactive	*h) regulated*
c) Plutonium	*i) chain*
d) solid	*j) force*
e) uranium(2)	*k) rods*
f) reactor	*l) hurt*

Nuclear Reaction

Inside the reactor of an atomic power plant, 1) ____ atoms are 2) ____ apart in a controlled 3) ____ reaction. In a chain reaction, particles released by the splitting of the atom go off and strike other 4) ____ atoms splitting those. Those particles given off split still other atoms in a chain reaction. In nuclear power plants, control 5) ____ are used to keep the splitting 6) ____ so it doesn't go too fast. If the 7) ____ is not controlled, you could have an atomic bomb. But in atomic bombs, almost pure pieces of the element

Uranium-235 or 8)____, of a precise mass and shape, must be brought together and held together, with great 9) ____. These conditions are not present in a nuclear 10) ____. The reaction also creates 11) ____ material. This material could 12) ___ people if released, so it is kept in a 13) ____ form. [11]

Active Vocabulary

33. Give Russian equivalents of the following words and phrases. Try to memorize them.

Nouns and noun phrases

pellet	coolant	vessel
dime	sodium	loop of water
bundle	potassium	

Verbs and verbal phrases	**Adjectives**
to melt	intermediate
to contact	
to spin	

Reading Task: *Text D*

34. Answer the following questions and read the text below to check your answers.

1) Is the uranium bundle an extremely high-energy source of heat?
2) What can be used as the coolant fluid in reactors?

Inside a Nuclear Power Plant

To turn nuclear fission into electrical energy, the first step for nuclear power plant operators is to be able to control the energy given off by the enriched uranium and allow it to heat water into steam.

Enriched uranium is typically formed into inch-long (2,5-cm-long) pellets, each with approximately the same diameter as a dime. Next the pellets are arranged into long **rods**, and the rods are collected together into **bundles**. The bundles are submerged in water inside a pressure vessel. The water acts as a coolant. For the reactor to work, the submerged bundles must be slightly supercritical. Left to its own devices, the uranium would eventually overheat and melt.

To prevent overheating, **control rods** made of a material that absorbs neutrons are inserted into the uranium bundle using a mechanism that can raise or lower the control rods. Raising and lowering the control rods allow operators to control the rate of the nuclear reaction. When an operator wants the uranium core to produce more heat, the control rods are raised out of the uranium bundle (thus absorbing fewer neutrons). To create less heat, they are lowered into the uranium bundle. The rods can also be lowered completely into the uranium bundle to shut the reactor down in the case of an accident or to change the fuel.

The uranium bundle acts as an extremely high-energy source of heat. It heats the water and turns it to steam. The steam drives a turbine, which spins a generator to produce power. Humans have been harnessing the expansion of water into steam for hundreds of years.

In some nuclear power plants, the steam from the reactor goes through a secondary, intermediate heat exchanger to convert another loop of water to steam, which drives the turbine. The advantage to this design is that the radioactive water/steam never contacts the turbine. Also, in some reactors, the coolant fluid in contact with the reactor core is gas (carbon dioxide) or liquid metal (sodium, potassium); these types of reactors allow the core to be operated at higher temperatures. [11]

Comprehension Check

35. Complete the following sentences.

1) The first step for nuclear power plant operators is to…
2) The pellets are arranged into …
3) The bundles are submerged in water inside …
4) Control rods are made of …
5) To create less heat, the control rods are …
6) The uranium bundle heats … and turns …
7) In some nuclear power plants, the steam from the reactor goes through …

36. Decide whether the following statements are true or false according to the text.

1) Pellets have the same diameter as a dime.
2) The pellets are collected together into bundles.

3) The submerged bundles must be highly supercritical.
4) Control rods can be raised or lowered by means of special mechanism.
5) The uranium core produces more heat when the control rods are raised out of the uranium bundle.
6) The rods are lowered completely into the uranium bundle in order to change the fuel.
7) The steam drives a generator to produce power.
8) The coolant fluid is always gas.

37. Answer the following questions and give examples.

1) How is enriched uranium formed?
2) What acts as a coolant?
3) When does the uranium overheat and melt?
4) What is to be done to prevent overheating?
5) What allows operators to control the rate of the nuclear reaction?
6) What should be done to shut the reactor down in case of an accident?
7) Does the uranium bundle act as an extremely high-energy source of heat? Why? Why not?
8) What is the advantage of a secondary, intermediate heat exchanger?
9) What types of reactors provide the core operation at higher temperatures?

38. Write an abstract of Text D in 2–3 sentences. Consult page 14.

Over to you

39. Discuss with your groupmates or in pairs what can go wrong inside a nuclear power plant.

Language Focus

40. Combine the words from the column on the left with the suitable nouns from the column on the right. Translate them into Russian.

1) nuclear power plant	a) uranium
2) enriched	b) bundles

3) 2,5-cm-long	c) rods
4) pressure	d) operators
5) submerged	e) bundle
6) control	f) pellets
7) uranium	g) heat exchanger
8) nuclear	h) vessel
9) intermediate	i) fluid
10) coolant	j) reaction
11) reactor	k) metal
12) liquid	l) core

41. Find the opposites to the following words in text D.

to lower →…	to dissipate →…	to prohibit →…
outside →…	partially →…	decrease →…
subcritical →…	to open →…	to separate →…

42. Match the terms with their definitions.

a) fission	*c) dime*	*e) pellet*
b) coolant	*d) bundle*	*f) heat exchanger*

1) a liquid or gas that is used to remove heat from something;
2) the action of dividing or splitting something into two or more parts;
3) a small, compressed mass of a substance;
4) a device for transferring heat from one medium to another;
5) a collection of things, or a quantity of material, tied or wrapped up together;
6) a ten-cent coin.

43. Make up the correct sentences.

Pellets …	*is formed*		rods.
Bundles …	*are arranged*	into	bundles.
Rods …	*are collected*	in	water.
Enriched uranium …	*are submerged*		pellets.

44. Fill in the correct prepositions, translate the phrases, then choose any three items and make up sentences of your own.

1) to give ___ energy; 2) to heat water ___ steam; 3) to act ___ a coolant; 4) to be made ___ a material; 5) to insert ___ the uranium

bundle; 6) to raise ___ the uranium bundle; 7) to shut the reactor ___; 8) the coolant fluid ___ contact ___ the reactor core; 9) to contact ___ turbine; 10) to operate ___ high temperatures.

Active Vocabulary

45. Give Russian equivalents of the following words and phrases. Try to memorize them.

Nouns and noun phrases

liner	personnel	security
containment	leakage	escape
precaution		

Verbs and verbal phrases

to take action
to refuel

Reading Task: *Text E*

46. Answer the following question and read the text below to check your answer.

What extra precautions are required outside a nuclear power plant?

Outside a Nuclear Power Plant

Once you get past the reactor itself, there's very little difference between a nuclear power plant and a coal-fired or oil-fired power plant, except for the source of the heat used to create steam. But as that source can emit harmful levels of radiation, extra precautions are required.

A concrete liner typically houses the reactor's pressure vessel and acts as a radiation shield. That liner, in turn, is housed within a much larger steel containment vessel. This vessel contains the reactor core, as well as the equipment plant workers use to refuel and maintain the reactor. The steel containment vessel serves as a barrier to prevent leakage of any radioactive gases or fluids from the plant.

Fig. 23. Germany's Brokdorf nuclear plant

An outer concrete building serves as the final outer layer, protecting the steel containment vessel. This concrete structure is strong enough to survive the kind of massive damage that might result from earthquakes or a crashing jet airliner. These secondary containment structures are necessary to prevent the escape of radiation/radioactive steam in the event of an accident (see Fig. 23).

Workers in the control room at the nuclear power plant can monitor the nuclear reactor and take action if something goes wrong. Nuclear facilities also typically feature security perimeters and added personnel to help protect sensitive materials. [11]

Comprehension Check

47. Decide whether the following statements are true or false according to the text.

1) The structures of a nuclear power plant and an oil-fired power plant are much alike.
2) A concrete liner acts as a radiation shield.
3) A steel containment vessel is housed in a liner.
4) Plant workers use the equipment contained in the vessel to refuel and maintain the reactor.
5) Steel containment vessel prevents leakage of many gases or fluids from the plant.
6) The outer concrete building can't withstand earthquakes or a crashing jet airliner.

48. Answer the following questions and give examples.

1) Why are additional precautions required at a nuclear plant?
2) What does a concrete liner usually house?
3) Where is the liner housed?
4) What does a containment vessel contain?
5) What does a steel containment vessel serve as?

6) What does an outer concrete building protect?
7) What are secondary containment structures necessary for?
8) What is control room used for?
9) What do nuclear facilities feature?

49. Fill in the following table according to text E.

	Function	Location
1) a concrete liner		
2) steel containment vessel		
3) outer concrete building		

50. Make an abstract of Text E in 3 sentences. Consult page 14.

Language Focus

51. Unjumble the words.

Model: ntalp → plant

1) nerli →…
2) dilehs →…
3) sleevs →…
4) gekaale →…
5) tarcoer →…
6) lerefu →…
7) nnaaiimt →…
8) uurrttsce →…
9) snornepel →…

52. Combine the words from the column on the left with the suitable nouns from the column on the right. Translate them into Russian.

1) harmful
2) extra
3) concrete
4) radiation
5) steel
6) outer
7) massive
8) radioactive
9) nuclear
10) sensitive

a) shield
b) level
c) vessel
d) liner
e) layer
f) precautions
g) material
h) damage
i) gases
j) facilities

53. Fill in the table with the derivatives.

Noun	Verb
difference	
creation	
	to emit
	to require
house	
	to contain
equipment	
	to refuel
maintenance	
	to prevent
protection	
	to survive
containment	
	to escape
	to monitor

54. Fill in the correct prepositions, translate the phrases, then choose any three items and make up sentences of your own.

1) difference ___ sth and sth; 2) except ___ sth; 3) to act ___ a shield; 4) ___ turn; 5) to be housed ___ a larger vessel; 6) to prevent leakage ___ a plant; 7) to result ___ earthquakes; 8) ___ the event ___ an accident; 9) workers ___ the control room ___ the nuclear power plant.

Active Vocabulary

55. Give Russian equivalents of the following words and phrases. Try to memorize them.

Nouns and noun phrases	Adjectives
city dump	lethal

Verbs and verbal phrases

to contribute	to pose	to explode
to purify	to guard	to spew

Reading Task: *Text F*

56. Answer the following question and read the text below to check your answer.

How many tons of wastes does a nuclear power plant generate per year?

Pros and Cons of Nuclear Power Plants

Whether you view nuclear power as the promise for a better tomorrow or a whopping down payment on a mutant-filled apocalypse, there's a good chance you won't be easily converted to the other side. After all, nuclear power boasts a number of advantages, as well as its share of downright depressing negatives.

As far as positives go, nuclear power's biggest advantages are tied to the simple fact that it doesn't depend on fossil fuels. Coal and natural gas power plants emit carbon dioxide into the atmosphere, contributing to climate change. With nuclear power plants, CO_2 emissions are minimal.

According to the Nuclear Energy Institute, the power produced by the world's nuclear plants would normally produce 2 billon metric tons of CO_2 per year if they depended on fossil fuels. In fact, a properly functioning nuclear power plant actually **releases** less radioactivity into the atmosphere than a coal-fired power plant. By not depending on fossil fuels, the cost of nuclear power also isn't affected by fluctuations in oil and gas prices.

As for negatives, nuclear fuel may not produce CO_2, but it does provide its share of problems. Historically, mining and purifying uranium hasn't been a very clean process. Even transporting nuclear fuel to and from plants poses a contamination risk. And once the fuel is spent, you can't just throw it in the city dump. It's still radioactive and potentially deadly (see Fig. 24).

On average, a nuclear power plant annually generates 20 metric tons of used nuclear fuel, classified as high-level radioactive waste. When you take into account every nuclear plant on the Earth, the combined total climbs to roughly 2,000 metric tons yearly.

Fig. 24. This storage facility near the site of the Chernobyl Nuclear Power Plant currently houses nuclear waste.

All of this waste emits radiation and heat, meaning that it will eventually corrode any container and can prove lethal to nearby life forms. As if this weren't bad enough, nuclear power plants produce a great deal of low-level radioactive waste in the form of radiated parts and equipment.

Eventually spent nuclear fuel will decay to safe radioactive levels, but it takes tens of thousands of years. Even low-level radioactive waste requires centuries to reach acceptable levels. Currently, the nuclear industry lets waste **cool** for years before mixing **it** with glass and storing it in massive cooled, concrete structures. In the future, much of this waste may be transported deep underground. In the meantime, however, this waste has to be maintained, monitored and guarded to prevent the materials from falling into the wrong hands. All of these services and **added** materials **cost** money – on top of the high costs required to build a plant.

Nuclear waste can pose a problem, and it's the result of **properly** functioning nuclear power plants. When something goes wrong, the situation can turn catastrophic. The Chernobyl disaster is a good recent example. In 1986, the Ukrainian nuclear reactor exploded, spewing 50 tons of radioactive material into the surrounding area, contaminating millions of acres of forest. The disaster forced the evacuation of at least 30,000 people, and eventually caused thousands to die from cancer and other illnesses. [11]

Comprehension Check

57. Decide whether the following statements are true or false according to the text.

1) Nuclear power depends on fossil fuels.
2) Coal and natural gas power plants contribute to climate change.

3) A coal-fired power plant discharges less radioactivity into the atmosphere than a nuclear power plant.
4) There is always a contamination risk while transporting nuclear fuel to and from plants.
5) A nuclear power plant generates high-level radioactive waste.
6) It takes tens of years for spent nuclear fuel to decay to safe radioactive levels.
7) Now the nuclear industry mixes wastes with glass and cool them for years.

58. Answer the following questions and give examples.

1) Does nuclear power have a number of drawbacks? Why? Why not?
2) Are CO_2 emissions minimal or maximal from nuclear power plants? Why? Why not?
3) What isn't the cost of nuclear power affected by?
4) What problems does nuclear fuel produce?
5) Why can't we throw nuclear fuel after it has been spent?
6) What do radioactive wastes emit?
7) How many years does low-level radioactive waste require to reach acceptable levels?
8) How are nuclear wastes stored?
9) What has to be done to radioactive wastes?

59. Find key words and phrases which best express the general meaning of each paragraph.

60. Write a summary of Text F. Consult page 10.

Over to you

61. Fill in the table according to Text F and discuss it in your group. You may find out additional information.

Pros and Cons of Nuclear Power Plants

Pros	Cons
1) … 2) … …	1) … 2) … …

Language Focus

62. Match the synonyms.

1) to pose	a) to discharge
2) contamination	b) to present
3) to release	c) pollution
4) to decay	d) fatal
5) lethal	e) to decompose
6) to guard	f) to supervise
7) to monitor	g) to throw out
8) to spew	h) to protect

63. Combine the words from the column on the left with the suitable nouns from the column on the right. Translate them into Russian.

1) depressing	a) cost
2) mutant-filled	b) forms
3) carbon	c) apocalypse
4) contamination	d) negatives
5) radioactive	e) area
6) life	f) risk
7) acceptable	g) level
8) surrounding	h) waste
9) high	i) dioxide
10) wrong	j) hands

64. Choose the contextual meanings of the words written in bold in Text B.

1. **release**
   a) разъединение
   b) выделять
   c) освобождать
   d) выбрасывать
2. **cool**
   a) охлаждать
   b) прохладный
   c) прохлада
   d) остывать
3. **cost**
   a) затраты
   b) стоить
   c) стоимость
   d) цена
4. **properly**
   a) особенно
   b) по сути
   c) правильно
   d) прилично

5. **added**
   a) добавлять
   b) дополнительный
   c) присоединять
   d) прибавленный

6. What does the word «**it**» mean?
   a) nuclear industry
   b) radioactive waste
   c) glass
   d) structure

65. Fill in the correct prepositions, translate the phrases, then choose any five items and make up sentences of your own.

1) to be tied ___ the fact; 2) to contribute ___ climate change; 3) according ___; 4) to depend __ sth; 5) to release ___ the atmosphere; 6) fluctuations ___ oil prices; 7) to transport ___ and ___ plants; 8) ___ average; 9) to take ___ account; 10) waste ___ the form ___ radiated parts; 11) to decay ___ safe radioactive levels; 12) ___ the meantime; 13) to fall ___ the wrong hands; 14) to spew ___ the surrounding area; 15) ___ least; 16) to die ___ cancer.

Language Development

66. Read the following sentences and fill in the words listed below.

a) nuclear	*f) no*	*k) turbines*
b) burn	*g) reactor*	*l) uranium*
c) chain	*h) robot*	*m) waste*
d) dangerous	*i) rods*	*n) water*
e) energy	*j) shielding*	

1) Is nuclear power renewable? – 1)____ .
2) Nuclear power stations use 2)_____ as fuel. They need very little fuel, compared to a «fossil» power station because there is much more 3)_____ in nuclear fuel.
3) The 4)_____ reaction inside the 5)_____ creates heat, which turns 6)_____ into steam to drive 7)_____, which drive generators to make electricity.
4) The fuel 8)_____ are safe to handle before they go into the reactor, it's only when they come out that you need to handle them with 9)_____ arms and heavy 10)_____.
5) 11)_____ power stations do not create atmospheric pollution, because they do not 12)_____ anything. However, the small amount of 13)_____ that they do produce is very 14)_____.

67. Translate the following text into English.

Ядерная энергия – энергия, высвобождаемая во время ядерных реакций в результате превращения массы в энергию: $E = mc^2$. В превращении задействована энергия связей в ядре атома. Ядерная энергия выделяется при ядерных реакциях двух видов – расщеплении ядер и ядерном синтезе. Цепная реакция деления характерна для атомной бомбы и ядерных реакторов. Реакция термоядерного синтеза протекает в звездах, водородной бомбе; с ее помощью можно получать дешевую энергию.

68. Put the statements into the correct column. Analyze the advantages and disadvantages of nuclear power.

Advantages	Disadvantages

- Nuclear power costs about the same as coal, so it's not expensive to make.
- Although not much waste is produced, it is very, very dangerous.
- It must be sealed up and buried for many years to allow the radioactivity to die away.
- Produces small amounts of waste.
- Nuclear power is reliable.
- Does not produce smoke or carbon dioxide, so it does not contribute to the greenhouse effect.
- Nuclear power is reliable, but a lot of money has to be spent on safety – if it does go wrong, a nuclear accident can be a major disaster.
- Produces huge amounts of energy from small amounts of fuel.
- People are increasingly concerned about this – in the 1990's nuclear power was the fastest-growing source of power in much of the world. In 2005 it's the second slowest-growing.

69. Discuss in your group the prospects of nuclear power development in Belarus. Find out additional information.

Follow Up

70. Read the texts of Unit V again and make notes under the following headings. Then use your notes to talk about *Nuclear Power*.

1. The opinions related to nuclear power.
2. Describe the process of nuclear fission.
3. Subcriticality, criticality and supercriticality.
4. Inside and outside a nuclear power plant.
5. Advantages and disadvantages of a nuclear power plant.

REVIEW

Check Your Knowledge

1. Read the following text and fill in the missing words.

a) fission	*e) except*	*i) Uranium rods*
b) way	*f) drives*	*j) as*
c) modern	*g away*	*k) pumped*
d) form	*h) split*	*l) steam*

How it Works

Nuclear power stations work in pretty much the same 1) _____ as fossil fuel-burning stations, 2) _____ that a "chain reaction" inside a nuclear reactor makes the heat instead.

The reactor uses 3) _____ as fuel, and the heat is generated by nuclear 4) _____. Neutrons smash into the nucleus of the uranium atoms, which 5)_____ roughly in half and release energy in the 6)_____ of heat.

Carbon dioxide gas is 7) _____ through the reactor to take the heat 8) _____, and the hot gas then heats water to make 9) _____.

The steam 10) _____ turbines which drive generators.

11) _____ nuclear power stations use the same type of turbines and generators 12) _____ conventional power stations. [11]

2. Translate these phrases into English.

Турбогенератор, пар под давлением, грандиозная энергия, охладительные башни, синтез (слияние) ядер, ядерное деление, период полураспада, альфа-излучение, нейтрон, плутоний, спонтанное движение, пикосекунды, подвергаться, критичность ядерного реактора, активная зона, сталкиваться, регулирующий стержень, контролировать уровень ядерной реакции, погружать в воду, закрыть реактор в случае аварии, теплообменник, охлаждающая жидкость, дополнительные меры предосторожности, силовой корпус, защитная оболочка, радиационный экран, радиоактивные отходы.

3. Translate the text into Russian in written form.

How Is Nuclear Energy Measured?

By Jacquelyn Jeanty

Fig. 25. Nuclear energy appears in the form of radiation.

Measuring this form of energy can be done based on how it affects the air, how it's absorbed in the environment and how much damage it causes. According to Idaho State University, nuclear energy originates from changes that take place within the nucleus of an atom. The release of energy comes about when a neutron is displaced from an atom's nucleus. The energy released is in the form of radiation. When a material undergoes this type of structural change, the amount of activity taking place inside the atom is measured in curies or becquerels. These units of measurement are named after the individuals who discovered uranium and radioactivity – Pierre and Marie Curie and Henry Becquerel.

4. Analyze the table [4] and make generalizations about the data in written form. Use the plan given below.

Nuclear power (% of total primary energy supply)
IEA (International Energy Agency) 2007

France	42,6
Sweden	36,2

Lithuania	31,9
Armenia	27,7
Slovakia	24,8
Bulgaria	24,3
Switzerland	22,5
Belgium	21,9
Slovenia	21
Korea (Republic of)	17,9
Finland	17,3
Ukraine	16,1
Japan	15
Czech Republic	14,3
Hungary	13
Germany	12,3
Spain	10,3
United Kingdom	9,1
United States	9
Canada	8,8
Russian Federation	6,1

Plan:

1. What the table shows.
2. What the numbers represent.
3. Make a thesis (a statement or an opinion that is presented with evidence in order to prove that it is true).
4. Support your thesis.
5. Make an appropriate conclusion.

Use the phrases:

The table shows…
A wide range in the percentage…
A number of…
According to the data…
If to compare…
We can sum up…

Text 1.

Energy Engineering – A New Engineering Discipline

Energy has become a topic of huge importance and interest to individual citizens, industry and government. The increased realization of possibly catastrophic climatic change, the increased price of oil and gas as energy sources, and the realization that oil is a finite resource have combined to prompt governmental incentives to place sustainable and renewable energy generation as a national priority. Ireland has published an Energy White Paper (White Paper) ("белая книга" – официальный правительственный документ по какому-л. вопросу) for the first time in thirty years with targets for energy efficiency (20% energy savings by 2020) and for renewable energy usage in electricity (33% renewable energy penetration by 2020), in heat (12% by 2020) and in transport (10% biofuels penetration). This will require significant investment and a substantial number of highly trained engineers who can make this happen.

What is Energy Engineering?

Energy engineering involves sourcing, assessing, designing, converting, transmitting and supplying useful energy to meet our needs for electricity, transportation and heating and cooling.

What Makes Energy Engineering Students Different?

During this degree programme energy engineers will be provided with core theoretical and practical skills from the broad disciplines of civil engineering (including fluids, design and structures), electrical engineering (including electrical machines, control and power systems), mechanical engineering (for example, mechanics, thermodynamics, combustion), and chemical and process engineering (biomass).

Energy engineering students will be equipped with the specialist skills needed by professional energy engineers, engaging in implementation of energy planning and policy and of infrastructural design, as required to meet national and international energy requirements.

How is the Programme Structured?

As with all engineering programmes, the student learning experience is a layered one, with a mathematical and scientific under-

pinning. Students take foundational scientific, mathematical, and civil, mechanical and electrical engineering subjects in the first three years of the programme. Some specialist energy modules will also be included. The objective in this foundational phase is to ensure that students have the requisite diverse knowledge from civil, mechanical and electrical engineering, to allow them to focus on energy engineering at fourth year degree level.

The programme differs substantially from other UCC engineering degree programmes in that it is designed in an integrative manner: the foundation subjects developed in the first three years lead to a focused fourth year that is designed to ensure that graduates possess all the principal knowledge strands required by the energy sector. The discipline requires a broad but well-definable set of skills which are packaged within the fourth-year programme. Providing the students with this targeted set of skills is the paramount learning objective of the programme

The professional and industrial focus of the programme is highlighted by the inclusion of a paid work placement of approximately five months duration between the third and fourth years, while fourth year includes a major design exercise. The professional requirements for subjects such as ethics and economics, the ability to communicate well and to work in teams are all infused into the programme.

It is envisaged that five years of University education will be required by students who seek Chartered status. The B.E. (Bachelors in Energy) programme design team are currently designing a further programme – the Masters in Energy Engineering.

Are There Programmes Like This Elsewhere?

UCC will be a first University in Ireland to provide such a level-eight programme. A number of leading institutions internationally offer engineering undergraduate programmes focussing specifically on energy engineering.

Stanford University offers a Degree in Energy Resources Engineering. Penn State University's has an energy engineering programme starting in Autumn 2007. University of New South Wales has been offering a B.E. degree in Renewable Energy Engineering since 2003 and also has a B.E. degree in Photovoltaics and Solar Energy.

Additionally, several courses currently focus on a subset of the energy engineering discipline or have energy as a partial focus of the degree including

In the island of Ireland, Limerick Institute of Technology offer a Bachelor of Science in Renewable and Electrical Energy.

In Britain, Heriot-Watt School of Engineering and Physical Sciences offer a B.Eng. in Mechanical Engineering with Energy Engineering; the University of Leeds offers both a B.Eng. in Chemical and Energy Engineering and a B.Eng in Energy and Environmental Engineering.

The University of Reykjavik and the University of Northern Texas (starting in 2007) both offer degrees in Mechanical and Energy engineering.

Is There a Need For Energy Engineers?

Energy engineers are needed to address some of the most challenging issues facing the world today, namely how to

1) deliver energy to a growing global population (6.4 billion people now, to 8.1 billion in 2030 – 1.6 billion people today have no access to electricity)

2) reduce the human impact on the climate (energy accounts for 80% of EU greenhouse gas emissions)

3) prepare for the global peaking of oil production and further price increase with innovative, sustainable engineering solutions.

Are There Cgareer Opportunities in Energy Engineering?

Energy engineers will be involved in a range of careers that include design of renewable energy devices, construction of (renewable and non-renewable) power plants, design and control of electrical distribution systems, design of energy systems for buildings, project management, formation of future energy policy, energy technology transfer and energy engineering consultancy.

Text 2.

What Is Green Engineering?

"Green Engineering is the use of advanced measurement and control techniques to design, develop, and improve products and technologies resulting in environmental and economic benefits." The good news is that, just as environmental issues are becoming more and more critical to humankind, we now have affordable technologies that enable us monitor and manage our (bio-)systems, reduce the greenhouse gases we emit, lower the amount of energy we consume, and thereby reduce our costs while benefiting our planet. Every engineer is becoming a "green engineer" because all of us are now intent on reducing carbon footprints and in saving money by reducing the energy consumption of the products and processes we design and control.

How Is Green Engineering Done?

Today, an increasing number of scientists and engineers are designing complex feedback and control systems that enable them to:

1. Monitor multiple data feeds from a myriad of sensors that detect and capture analog signals (temperature, humidity, pH, gases, chemicals) in real time.
2. Analyze these streams of input in near real time.
3. Correlate the relationships among the inputs to create a dynamic model of a complex system.
4. Take compensating or corrective actions by sending signals to trigger actions based on real-time events, triggers, and thresholds.

What Enabling Technologies Are "Green Engineers" Using?

What makes green engineering easier to do today than ever before are the cost effective and convenient tools we now have that enable us to sense, detect, analyze, monitor, and control multiple parallel processes with great precision at relatively low costs. Here are some core enabling technologies that are commonly used in green engineering applications:

- High-Speed and High-Resolution Measurements. There are literally tens of thousands of different sensors available to measure most real world phenomena. Many of these sensors are inexpensive enough that they can be widely distributed. Most sensors can now transmit their signals and data wirelessly. Their locations can be precisely pinpointed using GPS technology. Their data feeds can be gathered and analyzed remotely using low-cost Internet connections. Today's sensors are able to gather and to report extremely detailed, high-resolution measurements and send those measurements immediately.
- Advanced Analysis and Signal Processing. As all of this high-speed, high-resolution information arrives, we need to be able to make sense of it, to convert it to engineering measurements, to digitize it, to analyze the data in near real time, and to visualize and understand the patterns that emerge. Advances in software instrumentation now make it straightforward to perform very complex computations on these multiple signal streams as their inputs are being received.
- High-Speed and Advanced Control. As the signals are being processed, it's now possible to trigger appropriate actions in near real time in order to control or to alter processes with great preci-

sion, using a combination of open and closed loop controls, and to monitor the results of the actions taken.

- Embedded System Technology. Computers are now able to be embedded everywhere. Intelligent systems are found in many devices, from cell phones to thermostats to windmills. We no longer have to rely on general-purpose computers to sense, monitor, analyze, and control our environment. Most of the devices we use have computing and communications technology embedded in them.

A Bottoms Up, Globally Distributed Phenomenon

As my research showed, green engineering is taking place all around the globe. Keeping track of all of these initiatives is a daunting task. In fact, it's kind of like the spread of the Internet. Each engineering team monitors the signals they care about, in the spatial temporal resolution that's appropriate for the task at hand, and controls the outputs and actions that make sense for their applications. As they do so, they're collecting large amounts of very granular data in real time. So, for example, the Malaysian engineer, Thiru Subramaniam, the CTO from Chiller Energy Management Systems (CEMS), has been monitoring the temperatures on the outside of a dozen buildings in Malaysia and Singapore every 10 seconds for two years. He has watched the ambient temperature increase two degrees over the last two years. He pointed out that someone is probably also monitoring the temperature in the nearby seas. Correlating the ocean temperature and the external building temperatures might be useful.

Taking Advantage of Globally Shared Metadata Frameworks and Mapping

One of the most encouraging aspects about the real-time data being gathered in many green engineering projects—especially those that are related to monitoring the environment—is that many of these initiatives are setting up open frameworks for encoding and sharing the data they are capturing and analyzing. For an example of one such project, see the Global Lake Ecological Observatory Network at Gleon.org. This is an informal, grass roots effort by researchers in a variety of academic and research institutions to instrument fresh water lakes around the world in order to be able to monitor them—both as a way to monitor water quality and environmental issues and also to use these lakes as an early warning system for the overall health of our planet.

By *Patty Seybold*

Text 3.

Energy and Ecology

Production, transport and exploitation of the energy, all have a great impact on environment and ecosystems. Unfortunately so, energy has almost always negative impact on the environment, from direct ecological disasters like spilling of the oil, acid rains and radioactive emission, to indirect effects like the global warming. Since the energetic needs of the mankind will continue its growth in the next decades as well, some measures which would as much as possible decrease the influence of energy exploit to an environment are really a necessity. The most dangerous energy sources are currently fossil fuels (coal, oil and natural gas), and potential danger comes also in form of the used radioactive fuel from nuclear power plants (highly radioactive waste). Fossil fuels are dangerous because when combusting, they release large quantities of carbon dioxide, and radioactive waste is always dangerous because it influences the structure of organisms on a very basic level.

Majority of the world's energy is still gained from ecologically unacceptable energy sources, especially fossil fuels which are still dominant energy source. Since fossil fuels have coal as their base, normal combustion of these fuels results in carbon dioxide (CO2) which is a greenhouse gas. This carbon dioxide mostly ends up in the atmosphere and with its greenhouse effect causes the global warming. Even more dangerous is the gas that is released during the incomplete fuel combustion (combustion without the needed amount of oxygen), and this is carbon monoxide (CO). Carbon monoxide is extremely poisonous gas without color, taste or scent, and its concentration of just 0,6% is causing death after only 15 minutes of the inhalation.

At this moment, not single one fossil fuel isn't completely purified, and so during the combustion some other harmful gases like sulfur dioxide or nitrogen oxide are getting released as well. These gases later react with the water steam in the clouds forming drops that are falling on earth in the form of weak sulfuric acid and nitric acid - acid rains, and these rains have extremely negative impact on all the ecosystems they're catching. Combustion of some energy sources results in the form of tiny particles of minerals which are later forming the ashes, but certain number of these particles rises to the atmosphere carried by swirl of smoke. These particles are very dangerous for human health.

Text 4.

Types of Energy

Chemical and Mechanical Energy

An early source of energy, or prime mover, used by humans was animal power, i.e., the energy obtained from domesticated animals. Later, as civilization developed, wind power was harnessed to drive ships and turn windmills, and streams and rivers were diverted to turn water wheels. The rotating shaft of a windmill or water wheel could then be used to crush grain, to raise water from a well, or to serve any number of other uses. The motion of the wind and water, as well as the motion of the wheel or shaft, represents a form of mechanical energy. The source of animal power is ultimately the chemical energy contained in foods and released when digested by humans and animals. The chemical energy contained in wood and other combustible fuels has served since the beginning of history as a source of heat for cooking and warmth. At the start of the Industrial Revolution, water power was used to provide energy for factories through systems of belts and pulleys that transmitted the energy to many different machines.

Heat Energy

The invention of the steam engine, which converts the chemical energy of fuels into heat energy and the heat into mechanical energy, provided another source of energy. The steam engine is called an external-combustion engine, since fuel is burned outside the engine to create the steam used inside it. During the 19th cent, the internal-combustion engine was developed; a variety of fuels, depending on the type of internal-combustion engine, are burned directly in the engine's chambers to provide a source of mechanical energy. Both steam engines and internal-combustion engines found application as stationary sources of power for different purposes and as mobile sources for transportation, as in the steamship, the railroad locomotive (both steam and diesel), and the automobile. All these sources of energy ultimately depend on the combustion of fuels for their operation.

Electrical Energy

Early in the 19th cent, another source of energy was developed that did not necessarily need the combustion of fuels-the electric generator, or dynamo. The generator converts the mechanical energy of a conductor moving in a magnetic field into electrical energy, using the principle of electromagnetic induction. The great

advantage of electrical energy, or electric power, as it is commonly called, is that it can be transmitted easily over great distances. As a result, it is the most widely used form of energy in modern civilization; it is readily converted to light, to heat, or, through the electric motor, to mechanical energy again. The large-scale production of electrical energy was made possible by the invention of the turbine, which efficiently converts the straight-line motion of falling water or expanding steam into the rotary motion needed to turn the rotor of a large generator.

Nuclear Energy

The development of nuclear energy made available another source of energy. The heat of a nuclear reactor can be used to produce steam, which then can be directed through a turbine to drive an electric generator, the propellers of a large ship, or some other machine. In 1999, 23% of the electricity generated in the United States derived from nuclear reactors; however, since the 1980s, the construction and application of nuclear reactors in the United States has slowed because of concern about the dangers of the resulting radioactive waste and the possibility of a disastrous nuclear meltdown.

Environmental Considerations

The demand for energy has increased steadily, not only because of the growing population but also because of the greater number of technological goods available and the increased affluence that has brought these goods within the reach of a larger proportion of the population. For example, despite the introduction of more fuel-efficient motor vehicles (average miles per gallon increased by 34% between 1975 and 1990), the consumption of fuel by vehicles in America increased by 20% between 1975 and 1990. The rise in gasoline consumption is attributable to an increase in the number of miles the average vehicle traveled and to a 40% increase in the same period in the number of vehicles on the road. Since 1990 average fuel efficiency has changed relatively little, while the number of vehicles, the number of miles they travel, and the total amount of fuel consumed has continued to increase.

As a result of the increase in the consumption of energy, concern has risen about the depletion of natural resources, both those used directly to produce energy and those damaged during the exploitation of the fuels or as a result of contamination by energy waste products. Most of the energy consumed is ultimately generated by the combustion of fossil fuels, such as coal, petroleum, and natural gas, and the world has only a finite supply of these fuels,

which are in danger of being used up. Also, the combustion of these fuels releases various pollutants, such as carbon monoxide and sulfur dioxide, which pose health risks and may contribute to acid rain and global warming. In addition, environmentalists have become increasingly alarmed at the widespread destruction imposed on sensitive wildlands (e.g., the tropical rain forests, the arctic tundra, and coastal marshes) during the exploitation of their resources.

The Search for New Sources of Energy

The environmental consequences of energy production have led many nations in the world to impose stricter guidelines on the production and consumption of energy. Further, the search for new sources of energy and more efficient means of employing energy has accelerated. The development of a viable nuclear fusion reactor is often cited as a possible solution to our energy problems. Presently, nuclear-energy plants use nuclear fission, which requires scarce and expensive fuels and produces potentially dangerous wastes. The fuel problem has been partly helped by the development of breeder reactors, which produce more nuclear fuel than they consume, but the long-term hopes for nuclear energy rest on the development of controlled sources using nuclear fusion rather than fission. The basic fuels for fusion are extremely plentiful (e.g., hydrogen, from water) and the end products are relatively safe. The basic problem, which is expected to take decades to solve, is in containing the fuels at the extremely high temperatures necessary to initiate and sustain nuclear fusion.

Another source of energy is solar energy. The earth receives huge amounts of energy every day from the sun, but the problem has been harnessing this energy so that it is available at the appropriate time and in the appropriate form. For example, solar energy is received only during the daylight hours, but more heat and electricity for lighting are needed at night. Despite technological advances in photovoltaic cells, solar energy has not become a more significantly more financially competitive source of energy. Although several solar thermal power plants are now in operation in California, they are not yet able to compete with conventional power plants on an economic basis.

Some scientists have suggested using the earth's internal heat as a source of energy. Geothermal energy is released naturally in geysers and volcanoes. In California, some of the state's electricity is generated by the geothermal plant complex known as the Geysers, which has been in production since 1960, and in Iceland, which is geologically very active, roughly 90% of the homes are heated by geothermal energy.

Still another possible energy source is tidal energy. A few systems have been set up to harness the energy released in the twice-daily ebb and flow of the ocean's tides, but they have not been widely used, because they cannot operate turbines continuously and because they must be built specifically for each site.

Another direction of research and experimentation is in the search for alternatives to gasoline. Possibilities include methanol, which can be produced from wood, coal, or natural gas; ethanol, an alcohol produced from grain, sugarcane, and other agriculture plants and currently used in some types of U.S. motor fuel (e.g., gasohol and E85, a mixture of 85% ethanol and 15% gasoline); compressed natural gas, which is much less polluting than gasoline and is currently used by a 1.5 million vehicles around the world; and electricity, which if ever practicable would be cheaper and less polluting, especially if derived from solar energy, rather than gasoline.

Text 5.

Wood Fuel Sources

There are many types of wood fuel from a wide variety of sources. Certain types and sources of woodchips can often be better suited for certain applications than others. In addition to high-quality planning, engineering, and construction, successful biomass heating projects need to secure a sufficient fuel supply at the right price. Equally important is that the type and source of chip is properly suited to the size and design of the heating system. There are two main categories of wood species— hardwoods and softwoods. Hardwoods are typically deciduous trees like maple, oak, birch, and ash. Softwoods are typically coniferous trees like pine, cedar, hemlock, spruce, and fir. Both have similar energy values but softwoods generally have a slightly higher moisture content and can be less dense. For these reasons, hardwood trees are generally preferable to softwood as a fuel source. There are four main source categories of woody biomass fuels:

1) residues from sawmills;
2) low-grade wood from forest management;
3) low-grade wood from land development;
4) wood waste from communities.

Residues from Sawmills. There are typically three types of wood residues from sawmills-bark removed from the log prior to sawing, sawdust and shavings, and chips made from the slabs and off cuts. Each material has different characteristics that dictate the best use.

Bark. Bark is typically burned onsite to fire the mill's wood kilns or is sold as mulch. Soft wood bark like hemlock, cedar, and to a lesser extent, pine have a high market value for mulch in gardens and flower beds. Hardwood bark is sometimes used as a bulking agent for composting. Although bark has a high Btu content per pound (more than chips), bark also has a higher mineral/ash content.

Sawdust. Sawdust is typically sold to farmers as bedding for livestock. Sawdust is also used in making wood fuel pellets. Sawdust is frequently burned in kilns for drying lumber, but this practice is now less common than in the past.

Woodchips. Woodchips are the best-suited fuel for institutional – scale biomass heating systems. Mill chips tend to be the highest-quality fuel available for chip-fired heating systems. Mill chips are produced from the waste wood (off cuts and slabs from sawing logs into lumber). Because logs are debarked before sawing, mill chips are very clean and have a relatively low ash content.

In addition to sawmill by-products such as sawdust, bark, and woodchips that can be used directly as a biomass fuel, these materials (primarily sawdust and shavings) can be further processed into a refined biomass fuel – pellets. Historically, pellets have been sold almost exclusively in bags to the residential heating market; however, they are now being delivered in bulk to fuel central boiler systems.

Text 6.

Natural Gas

Natural gas is nothing new. In fact, most of the natural gas that is brought out from under the ground is millions and millions of years old. However, it was not until recently that methods for obtaining this gas, bringing it to the surface, and putting it to use were developed.

Before there was an understanding of what natural gas was, it posed somewhat of a mystery to man. Sometimes, such things as lightning strikes would ignite natural gas that was escaping from under the earth's crust. This would create a fire coming from the earth, burning the natural gas as it seeped out from underground. These fires puzzled most early civilizations, and were the root of much myth and superstition. One of the most famous of these types of flames was found in ancient Greece, on Mount Parnassus approximately 1,000 B.C. A goat herdsman came across what looked like a 'burning spring', a flame rising from a fissure in the rock.

The Greeks, believing it to be of divine origin, built a temple on the flame. This temple housed a priestess who was known as the Oracle of Delphi, giving out prophecies she claimed were inspired by the flame.

These types of springs became prominent in the religions of India, Greece, and Persia. Unable to explain where these fires came from, they were often regarded as divine, or supernatural. It wasn't until about 500 B.C. that the Chinese discovered the potential to use these fires to their advantage. Finding places where gas was seeping to the surface, the Chinese formed crude pipelines out of bamboo shoots to transport the gas, where it was used to boil sea water, separating the salt and making it drinkable.

Britain was the first country to commercialize the use of natural gas. Around 1785, natural gas produced from coal was used to light houses, as well as streetlights

Manufactured natural gas of this type (as opposed to naturally occurring gas) was first brought to the United States in 1816, when it was used to light the streets of Baltimore, Maryland. However, this manufactured gas was much less efficient and environmentally friendly, than modern natural gas that comes from underground.

Naturally occurring natural gas was discovered and identified in America as early as 1626, when French explorers discovered natives igniting gases that were seeping into and around Lake Erie. The American natural gas industry got its beginnings in this area. In 1859, Colonel Edwin Drake (a former railroad conductor who adopted the title 'Colonel' to impress the townspeople) dug the first well. Drake hit oil and natural gas at 69 feet below the surface of the earth.

Most in the industry characterise this well as the beginning of the natural gas industry in America. A two-inch diameter pipeline was built, running 5 and 1/2 miles from the well to the village of Titusville, Pennsylvania. The construction of this pipeline proved that natural gas could be brought safely and relatively easily from its underground source to be used for practical purposes.

In 1821, the first well specifically intended to obtain natural gas was dug in Fredonia, New York, by William Hart. After noticing gas bubbles rising to the surface of a creek, Hart dug a 27 foot well to try and obtain a larger flow of gas to the surface. Hart is regarded by many as the 'father of natural gas' in America. Expanding on Hart's work, the Fredonia Gas Light Company was eventually formed, becoming the first American natural gas company.

During most of the 19th century, natural gas was used almost exclusively as a source of light. Without a pipeline infrastructure, it

was difficult to transport the gas very far, or into homes to be used for heating or cooking. Most of the natural gas produced in this era was manufactured from coal, as opposed to transported from a well. Near the end of the 19th century, with the rise of electricity, natural gas lights were converted to electric lights. This led producers of natural gas to look for new uses for their product.

In 1885, Robert Bunsen invented what is now known as the Bunsen burner. He managed to create a device that mixed natural gas with air in the right proportions, creating a flame that could be safely used for cooking and heating. The invention of the Bunsen burner opened up new opportunities for the use of natural gas in America, and throughout the world. The invention of temperature-regulating thermostatic devices allowed for better use of the heating potential of natural gas, allowing the temperature of the flame to be adjusted and monitored.

Without any way to transport it effectively, natural gas discovered pre-WWII was usually just allowed to vent into the atmosphere, or burnt, when found alongside coal and oil, or simply left in the ground when found alone.

One of the first lengthy pipelines was constructed in 1891. This pipeline was 120 miles long, and carried natural gas from wells in central Indiana to the city of Chicago. However, this early pipeline was very rudimentary, and did not transport natural gas efficiently. It wasn't until the 1920's that any significant effort was put into building a pipeline infrastructure. After World War II welding techniques, pipe rolling, and metallurgical advances allowed for the construction of reliable pipelines. This led to a post-war pipeline construction boom lasting well into the 60's, creating thousands of miles of pipeline in America.

Once the transportation of natural gas was possible, new uses for natural gas were discovered. These included using natural gas to heat homes and operate appliances such as water heaters and oven ranges. Industry began to use natural gas in manufacturing and processing plants. Also, natural gas was used to heat boilers used to generate electricity. The transportation infrastructure made natural gas easier to obtain, and as a result expanded its uses.

A Brief History of Regulation

In 1938, the U.S. government first regulated the natural gas industry. At the time, members of the government believed the natural gas industry to be a 'natural monopoly'. Because of the fear of possible abuses, such as charging unreasonably high prices, and given the rising importance of natural gas to all consumers, the

Natural Gas Act was passed. This Act imposed regulations and restrictions on the price of natural gas to protect consumers. In the 1970's and 1980's, a number of gas shortages and price irregularities indicated that a regulated market was not best for consumers, or the natural gas industry. Into the 1980's and early 90's, the industry gradually moved towards deregulation, allowing for healthy competition and market based prices. These moves led to a strengthening of the natural gas market, lower prices for consumers and the discovery of more natural gas.

Today, the natural gas industry is regulated by the Federal Energy Regulatory Commission (FERC). While FERC does not deal exclusively with natural gas issues, it is the primary rule making body with respect to the minimal regulation of the natural gas industry.

Competition characterizes the natural gas industry as it is known today. The opening up of the industry, and the move away from strict regulation, has allowed for increased efficiency and technological improvements. Natural gas is now being obtained more efficiently, cheaply, and easily than ever before. However, the search for more natural gas to serve our ever growing demand requires new techniques and knowledge to obtain it from hard-to-reach places.

Today, the natural gas industry has existed in this country for over 100 years, and it continues to grow. Deregulation and the move toward cleaner burning fuels have created an enormous market for natural gas across the country. New technologies are continually developed that allow Americans to use natural gas in new and exciting ways. With all of the advantages of natural gas, it is no wonder it has become the fuel of choice in this country, and throughout the world.

Text 7.

Fuel

Fuel material that can be burned or otherwise consumed to produce heat. The common fuels used in industry, transportation, and the home are burned in air. The carbon and hydrogen in fuel rapidly combine with oxygen in the air in an exothermal reaction – one that liberates heat. Most of the fuels used by industrialized nations are in the form of incompletely oxidized and decayed animal and vegetable materials, or fossil fuels, specifically coal, peat, lignite, petroleum, and natural gas. From these natural fuels other artificial ones can be derived. Coal gas, coke, water gas, and producer

gas can be made using coal as the principal ingredient. Gasoline, kerosene, and fuel oil are made from petroleum. For most transportation, fuel must be in a liquid form.

There is a growing concern about the environmental contamination caused by the burning of great amounts of fossil fuels and about the increasing expense of finding them and processing them into easily usable forms. During the last 100 years the amount of carbon dioxide in the atmosphere has increased, and there is evidence that this phenomenon may be due to the burning of fossil fuel. Use of biomass, which consists of plants or plant waste, would not produce excess carbon dioxide because the plants absorb the gas for their growth. Wood is not as concentrated a form of energy as fossil fuels, but it can be converted into a more energy-rich fuel called charcoal. Burning fossil fuel also releases acidic oxides of sulfur and nitrogen, which are deposited on the earth in rainwater. The clearing of forests, particularly in the tropical regions, also threatens to increase the amount of carbon dioxide in the atmosphere because the forests utilize carbon dioxide for growth.

The amount of fossil fuel available is limited and new methods of recovery are being developed. One proposed alternative fuel is hydrogen, which is now employed as a fuel only for a few special purposes because of its high cost. Hydrogen can be produced by electrolysis of water for which nonfossil fuels would supply the energy. Solar energy could be utilized either by direct conversion to electricity using photovoltaic cells or by trapping solar heat. Fuels are rated according to the amount of heat (in calories or Btu) they can produce. Nuclear fuels are also possible substitutes for fossil fuels. Nuclear fuels are not burned; they undergo reactions in which the nuclei of their atoms either split apart, i.e., undergo fission, or combine with other nuclei, i.e., undergo fusion. In either case, a small part of the nuclear mass is converted to heat energy. All nuclear fuels currently employed in practical, nonweapons applications react by fission.

High-energy fuels for jet engines and rockets are rated by their specific impulse in thrust per pound of propellant per second. Hydrogen, which is the lightest element, is usually used in the form of compounds, because the density of liquid hydrogen is low and therefore a large volume is required. Addition of aluminum powder or lithium increases the efficiency. Rockets usually have a self-contained supply of oxygen or some other oxidizer, such as ammonium, lithium, or potassium perchlorate. Fuels such as turpentine, alcohol, aniline, and ammonia use nitric acid, hydrogen peroxide, and liquid

oxygen as oxidizers. More power can be obtained by oxidizing hydrazine, diborane, or hydrogen with oxygen, ozone, or fluorine.

Nonrenewable fossil fuels—coal, petroleum, and natural gas—provide more than 85% of the energy used around the world. In the United States, fossil fuels comprise approximately 80% of the total energy supply, nuclear power provides about 7,7% and all renewable energy sources provide about 7%. (Note that these figures lump together electricity and all other forms of energy use, such as heat and transport fuel; in practice, electricity is best treated as a special category of energy consumption.) Wind power, active and passive solar systems, geothermal energy, and biomass are examples of renewable or alternative energy sources. Although such alternative sources make up a small fraction of total energy production today, their share is growing rapidly. As of 2006, wind power was the cheapest form of large-scale electric generation to install (measured by kilowatt-hours delivered) – cheaper than new coal plants, new nuclear plants, or solar cells, for example.

Scientists estimate that easily extractable fossil fuels will be largely used up during the twenty-first century: known petroleum reserves will last less than 50 years at current rates of use; the rate of discovery of new reserves is decreasing. Much larger reserves of coal exist, but could be extracted only at catastrophic environmental cost. Proponents of nuclear power are today urging that nuclear power has many virtues, including a zero output of greenhouse gasses such as carbon dioxide (released by burning fossil fuels). Opponents of nuclear power urge that it is unacceptable because of its high cost, its vulnerability to military and terror attack, possible accidental releases of radioactivity during fuel processing and operation, and the challenge of waste disposal. Further, critics argue that nuclear-power technologies cannot be disseminated globally without spreading at the same time much of the materials and know-how for producing nuclear weapons. For example, the U.S. government was concerned in 2006 that the Iranian government might be obtaining material for a secret nuclear-weapons program from its civilian nuclear power program.

Achieving wider use of renewable sources of energy is thus, seen by many planners as key for a sustainable, affordable, and peaceful global economy.

Text 8.

Alternative Energy Sources. Solar Energy

In our modern industrial society we consume vast amounts of energy to make our daily life more comfortable, productive and en-

joyable. All of us use energy every day – for heat and light in living and working areas, cooking, transportation, manufacturing, and entertainment. The choices we make about how we use energy – turning machines off when we're not using them or choosing to buy energy efficient appliances – impact our environment and our lives.

Energy comes from several different sources. These sources can be split into two main categories: non-renewable and renewable. Non-renewable types of energy include the three major types of fossil fuels – coal, oil and natural gas. Fossil fuels supply more than 90% of the world's energy. Oil leads with a share of about 40 percent of total world energy consumption, followed by coal (24 percent) and natural gas (22 percent). All of these are burned to produce power.

Fossil fuels are relatively easy to use to generate energy because they only require a simple direct combustion. However, a problem with fossil fuels is their environmental impact. Not only does their excavation from the ground significantly alter the environment, but their combustion leads to a great deal of air pollution. Carbon dioxide (CO_2) from burning fossil fuels is the largest source of greenhouse gases from human activities. Extra greenhouse gases we are putting into the atmosphere are causing global warming and climate change. Besides, these are fuels that are being consumed more rapidly than they are being replaced. That means that someday we could run out of these fuels.

Another nonrenewable source is uranium. Uranium is an element that gives us nuclear energy by splitting an atom's nucleus, and this process is called fission. Nuclear energy is a better source of energy because it doesn't put carbon dioxide into the atmosphere. But like all industrial processes, nuclear power generation has by-product wastes; tremendous steam of radioactive products and heat. Hazardous wastes and the possibility of a nuclear disaster are the principal concerns for nuclear power.

With the growing concerns over the environmental problems today (air pollution, global climate change, massive flooding in river systems, etc.) and the price of non-renewable energy sources soaring, we have to take a closer look at the alternative energy sources. Alternatives to the fossil fuels and nuclear power are renewable sources of energy and they are considerably more attractive in many ways. Renewable sources are derived and replenish quickly from nature and usually do not pollute our environment when used to generate electricity. The five renewable sources used most often include hydropower (water), solar, wind, biomass, and geothermal.

In the context of renewable energy, solar power is associated with the harnessing of the sun's present emissions of heat or light. There are a variety of types of technologies that can do this. Solar energy is typically divided into three categories: passive solar, active solar, and photovoltaic (electrical) solar energy. All of them produce solar energy, but in very different ways.

In active solar category the solar energy is directly converted in the application form. One of the simplest and economical ways to utilize solar energy is through solar thermal systems. Solar thermal technology is employed for collecting and converting the sun energy to heat energy for application such as water and air heating, cooking and drying, steam generation, distillation, etc.

Solar thermal technologies include solar heat collectors (flat-plate collectors, evacuated-tube collectors) and solar concentrating collectors. Flat-plate collectors are the most commonly used type of collector today. A typical flat-plate collector consists of a box containing a sheet of metal painted black, which absorbs the suns energy. In the most common design, liquids take the heat from the box and bring it into the building. This heated liquid, usually a water-alcohol mixture to prevent winter freezing, is used to heat water in a tank or is put through radiators to heat the air. Solar heat collectors sit on the rooftops of buildings and are generally used in hotels and homes.

Solar concentrating collectors (parabolic concentrators) use mirrors and lenses to concentrate and focus sunlight onto a receiver mounted at the system's focal point. The receiver absorbs and converts the sunlight into heat. This heat is then transported by means of a heated fluid (either water or molten salt) through pipes to a steam generator or engine where it is converted into electricity. There are also large centralized solar power plants, known as "power towers". Power tower is a large tower surrounded by small rotating (tracking) mirrors called heliostats. These mirrors align themselves and focus sunlight on the receiver at the top of tower, collected heat. This focused heat turns water into steam that is used to power a generator. Solar concentrating systems produce high temperatures that can be used for industrial purposes.

Photovoltaic (electrical) solar technologies directly convert solar radiation into electricity through the use of photovoltaic cells (PVs), also called solar cells. Photovoltaic or solar electric panels use semiconductor materials such as silicon to convert sunlight to electricity. Most solar cells are made from silicon because it is, so far, the most cost-effective material. Sunlight is composed of light

energy in the form of photons. When these photons strike the cell, some electrons in the cell material absorb sufficient energy to break away from their atoms and flow through the material to produce electricity. This electricity can either be used directly as it is or can be stored in the battery. The stored electrical energy then can be used at night.

PV technology can be used to meet our electricity requirements. Most houses with good roofs have enough space to generate a total of about 1/4 to 1/2 of their yearly electricity use. Solar photovoltaic panels can be installed on the rooftops. They can be flush mounted as well as tilted up. PV systems can also provide electricity in remote places deprived of grid power.

PVs can be used in a variety of applications. The simplest photovoltaic systems power small consumer goods such as calculators and wrist watches. Other applications include water pumps, street and car-park lighting, garden footpath lighting, etc. Some experimental cars also use PV cells. They convert sunlight directly into energy to power electric motors on the car. Solar photovoltaic panels are applied in satellites and spacecrafts as well.

Passive solar energy is energy or warmth obtained without any mechanical intervention. The most common of the passive solar technologies is referred to as direct solar gain. A direct gain system includes south-facing large windows that allow the sun's rays to heat surfaces inside the building. The result is that in cold weather the surfaces absorbs solar energy and radiates heat throughout the room.

Of all the solar energy technologies, photovoltaics show the greatest promise for worldwide acceptance and application. Working photovoltaics are relatively simple in design, have no moving parts, need very little maintenance and are environmentally benign. They simply and silently produce electricity whenever they are exposed to light. In the developing world PVs are seen as a very attractive option. They are especially useful for rural electrification, vaccine refrigeration and water pumping.

Solar energy demand has grown at about 25% per annum over the past 15 years but it has clearly not reach its full potential. The main reason for the lack of mass exploitation of solar power technologies is economic. In order for widespread generation of electricity using solar panels to be feasible it needs to be economically advantageous. In order for solar panels to be an economically viable choice for the production of electricity, production costs must go down and efficiency of the final product must go up.

The hidden factor behind the lack of widespread solar power production is the absence of mass consumer demand for solar technologies. If there is a demand for a product, there will be people that will supply that product at a cost that fulfills that demand. As a result, economic and efficient solar power technologies will be developed and exploit more quickly.

Text 9.

Potential Energy Resources in Belarus

Oil, Gas, Coal and Peat

Belarus is poor in most of these resources and needs to rely on imports. There is a low potential for significantly developing most of these resources in the near future.

Oil and casing-head gas. Oil deposits are concentrated in the Pripyat' depression in southern Belarus, with an oil-bearing area of about 30 thousand km^2. The initial extractable oil resources are estimated to be equal to 362.1 million tons. Currently, oil extraction in Belarus is shrinking. It is expected that by 2005 extraction of domestic oil in Belarus will be two times lower than in 1997. Respectively, import of oil and gas from Russia will rise by 50%, which means that Belarusian energy sector will mainly rely upon imported oil and gas rather than on domestic sources of these fuels.

Peat. Over 9000 peat deposits exist in Belarus, with initial peat reserves of 5.65 billion ton. In 1997 the total amount of extracted peat was about 1 million equivalent fuel. (1 kg of equivalent fuel is equal to 29 MJ or 27,773 BTU). The extracted peat is used partly for production of fertilizers and partly as a municipal fuel. It is anticipated that peat extraction in 2005 will be 5% lower than in 1994.

Shale. By quality, Belarusian shale is not an efficient fuel due to its high ash content and low combustion heat.

Brown coal. As of January 1992, three brown coal deposits were known of in Belarus. The coal is suitable for use as a municipal and household fuel. Exploitation of brown coal deposits in the near future is unrealistic because environmental problems caused by open-mining are unsolved.

Renewable Energy Sources

Belarus has the potential to develop several renewable energy sources., including small hydroelectric power plants, wind energy installations, bioenergy installations or biogas installations, solar water heaters, installations for briquetting and burning of plant cultiva-

tion wastes. These technologies could help Belarus meet its energy needs. However, the high cost of developing some of the sources may make wide-scale development unrealistic in the near future.

Hydroelectric Power Resources

The main existing plans for the development of small-scale hydroelectric power generation are: 1) restoration of SHPP that previously existed, by overhaul and partial re-equipment; 2) construction of new SHPP on reservoirs for integrated use; 3) construction of SHPP on industrial spillways; 4) construction of damless (riverbed) hydroelectric power plants on the rivers with significant water discharge. The hydropower unit capacity will be within the range from 50 to 500 kWt.

Wind Power Resources

The main direction of the use of wind energy installations (WEI) in the nearest future will be for pump drive installations and for heating water for agriculture. These application areas have minimum requirements for the quality of electric power (stability of frequency and voltage), which allows for simple WEI and makes them cheaper. It is especially promising to use WEI for pumping water for small-scale hydroelectric power plants. Economically sound potential of WEI is evaluated in 3 thousand tons of equivalent fuel.

In 1998 the Institute Belenergoset' conducted an assessment of wind speed and concluded that Belarus does not have weather conditions that favor wind energy installations with present state of the art equipment. Plans to create a new type of wind power installation which will be able to produce power at low wind speed may make the wide-scale use of WEI in Belarus possible in the future.

Bioenergy Installations

Bioenergy installations are currently under development and testing in the Scientific Research Center for Non-Traditional Power Engineering near Minsk. The results of this work will provide a more precise evaluation of the actual yield of tradable biogas. Even in case of low biogas yield, development of cheap and reliable bioenergy installations will be of great practical importance for the country. Application of bioenergy installations will allow improvement especially of the environmental situation around the large-scale stock-breeding farms and complexes, where at present huge amounts of unprocessed biomass are stored. Besides, it is possible to plan to obtain a significant quantity of high-quality organic fertilizers. This will enable a reduction in the production of mineral

fertilizers, which require a lot of power to produce. Potentially possible bulk yield of tradable biogas from a cattle-breeding complex (which has usually up to 100,000 cattle) is about 160 thousand tons of equivalent fuel per year.

At present, bioenergy installations are not used on the regular basis, since the problem of operation at low temperature remains unsolved. However, this source is considered as the only way to solve the problem of organic waste in agriculture and is one of the priorities for future development.

Solar Energy

The main direction of the solar energy application will be solar water heaters (SWH) and various solar installations for the intensification of drying and heating processes in agriculture. At present, solar cells are used in electronics, as an energy source for calculators, watches, etc., and household solar water heaters are becoming popular. Utilization of solar energy for other purposes on a wide-scale basis is a question of the nearest future.

Geothermal Resources

The thermal conditions of the depths of Belarus' territory have not be sufficiently investigated. According to preliminary data, the most favorable conditions for thermal water formation are in Pripyat' depression in southern Belarus.

The large depth of thermal waters, their relatively low temperature, high mineralization and low flow rate of boreholes (100–1150 m^3/day) does not allow thermal waters to be considered a considerable energy source at present.

Municipal Solid Waste

The content of organic matter in municipal waste is 40–75 %. Carbon makes up 35–40%, and ash content is 40–70%. Combustible components in municipal waste make up 50–88%, calorific power of solid municipal waste is 800–2000 kcal/kg.

In global practice the obtaining of energy from solid municipal waste is implemented in several ways: through burning, active and passive gasification. At present, the possibility of gasification of solid municipal waste for energy production is under investigation, since currently this technology does not exist in Belarus.

Nuclear Power

The issue of nuclear power plant (NPP) construction in Belarus is not a new one. It was planned to put into operation the first unit of the Minsk nuclear heat and power plant (2xl000MWt) in 1989.

Also, it was decided to build Belarusian NPP with capacity of 6000 MWt. These activities were suspended after the Chernobyl accident in 1986. Seventy percent of the fallout from Chernobyl landed in Belarus; 23% percent of Belarusian territory is contaminated.

In recent years the Belarusian government again explored the feasibility of constructing a nuclear power plant. For that purpose a special commission was formed in 1998: the Commission on the Evaluation of the Expediency of the Development of Nuclear Energy in Belarus. In late 1999, this Commission recommended that Belarus should not build a nuclear power plant within the next ten years.

Text 10.

Renewable Energy in Belarus

Introduction

The Republic of Belarus belongs to the group of countries without their own considerable energy and fuel resources (EFR). The EFR include: crude oil, natural gas, peat, water resources and biomass. Belarus' own power resources satisfy 15–17% of its EFR requirement.

There are practically no other sources of energy in Belarus other than those of renewable character. Therefore, the share of renewable energy amounts to 80% of the country's own EFR.

At present, the Republic of Belarus is in the process of implementing the *"Target electricity and heat provision program for achieving at least 25% of industrial production with the use of local types of fuel and alternative sources of energy by the year 2012"*. In order to provide 25% of electricity and heat with the use of local EFR, it is necessary to boost their production up to 5,93 million tons of oil equivalent (Mtoe) per year, and to use the secondary resources such as heat energy, as well as primary resources from wind turbines and biogas in the amount of 0.82 Mtoe per year. In light of the above, the plans assume that by the year 2012 the use of local energy resources, including secondary heat resources, wind, solar and biomass energy, will be increased by 2.8 Mtoe. So far emphasis has been placed on the implementation of the program focused on the use of wood and wood waste. The potential of other renewable sources of energy is not taken advantage of to a significant degree.

Renewable and Alternative Energy in the Energy Policy of Belarus

The concept of power safety considers the share that local fuel types have in the EFR balance to be one of the primary indicators. In Belarus, the share of local fuel types (LFT) in the overall bal-

ance currently equals 17%. In line with the assumptions, the share of LFT will be increased to 20.5% by 2010, 27.5% by 2015 and 31.6-34.5% by 2020.

The draft Act "On non-traditional and renewable sources of energy" is currently in consultation by the Council of Ministers. It is expected that the Act will set out (1) the directions of state regulations concerning development and the use of non-traditional and renewable sources of energy (NTRSR) and (2) the directions for public support of NTRSR.

The draft Act has not been published, but in line with official declarations its major assumptions relate to the following: (1) guaranteeing a power grid connection for all power systems using non-traditional and renewable sources of energy, (2) obligatory purchase of energy from such systems by state enterprises dealing with provision of energy, (3) a preferential energy tariff (it is expected that the preferential rates will be paid throughout the system's entire useful life).

By introducing such regulations, the Act "On non-traditional and renewable sources of energy" may serve as a guarantee of support for alternative and renewable energy sectors, and will help overcome numerous problems and obstacles on the path to increasing the share of renewable energy sources in the EFR structure to 25% and beyond. It is still too early a stage, however, to speak about the Act's effectiveness, as its provisions have to become widely known first.

Under the decision of the Council of Ministers of the Republic of Belarus No. 400 "On development of small and non-traditional power plants" dated 24 April 1997, whose wording was amended by the decision No. 288 "On the development of small and non-traditional power plants" dated 28.02.2002, (1) a concept has been worked out for the development of small and non-traditional power plants in the Republic of Belarus, (2) a guarantee has been given for the connection, to the power grid of the Republic of Belarus, of small and non-traditional power plants owned by business entities, regardless of their form of ownership, and the payment for power provided by such entities has been guaranteed, (3) a system has been worked out for determining tariffs for electricity purchased by the power system from small and non-traditional power plants. At the same time, decision No. 91 by the Ministry of Economy of the Republic of Belarus dated 31.05.2006 sets out an increased tariff for purchasing electricity from renewable energy sources with

the factor of 1.3, which equals approximately 10–12 eurocents (and for minim heat plants using natural gas – 0,85).

However, the existing mechanisms are insufficient to stimulate the development of the sector based on renewable energy sources.

In line with the "Target program...." and other comprehensive programs for state authority organs (ministries, corporations, local executive committees, etc.) tasks have been defined aimed at improving the use of local power resources, with the level of increasing the use of LFT by 2012 defined, as well as specific actions have been devised with the year of commissioning, as well as the amount and sources of financing also determined. Thus, no stimulation for the implementation of the "Target program..." has been envisaged, and administrative guidelines have been defined instead.

There are three major institutions responsible for shaping and implementing the policy on renewable energy sources: Energy Effectiveness Department of the State Standardization Committee of the Republic of Belarus, the Ministry of Energy and the Ministry of Natural Resources and Environment Protection. There is, however, no single coordinating body. The duties of those institutions include planning, implementing and monitoring activities related to renewable and alternative energy sources. The Belarusian Academy of Sciences is responsible for development of the scientific and technical background for implementation of projects related to renewable and alternative energy sources.

The potential of renewable energy sources in Belarus

The potential of wind energy is estimated to equal 1,9–2,0 Mtoe per year. The potential of wind farm energy is estimated at 220 billion kWh. The wind energy sector is growing rather slowly in Belarus, as investors are faced with significant problems in the Republic of Belarus, and the development of wind farms is not too profitable for local power systems. There are only two regular wind turbines existing in Belarus at present. Their power rating equals 270 kW and 660 kW respectively and they are situated in the village of Druzhnaya in the Myadele Region. Architectural designs have been worked out for the construction of Belarus' largest wind turbines with the power rating of 1,2 MW, to be situated in the village of Grabniki (Unitary Republican Enterprise "Grodnoenergo"). The government has commenced an analysis of the wind energy sector development program in Belarus for the years 2008–2014. It is expected that wind farms should be commissioned in 2010 with the total power output of 3,7 MW, by 2012–5,2 MW, and by 2014–15 MW. The projects are currently in the planning stage, and envi-

sage establishing partnerships with local power systems in order to construct wind farms with the estimated total power output of 20–30 MW each. In addition, the relevant standardization and legal base should be prepared by 2010. In order to effectively implement wind energy related projects, it is necessary to carry out actual measurements to determine the size of wind energy resources, launch the production of equipment suitable for Belarus' climatic conditions, as well as gather experience in designing, implementing and running wind farms.

The potential of solar energy for hot water provision is estimated at 1.25–1.75 Mtoe per year, and for production of electricity –at 1,0–1,25 Mtoe per year. The solar power sector has no industrial significance at the moment. Only several experimental systems exist at present. No use of solar energy on a wider scale is planned in Belarus in the nearest future.

The major directions in the production of energy with the use of biomass are as follows: (1) crop waste; (2) animal breeding waste gas; (3) wood and wood waste; (4) phytomass (plant biomass) and (5) municipal waste.

The use of crop waste as fuel is a new direction in the production of energy in the Republic of Belarus. The overall energy potential of crop waste is estimated at 1.46 Mtoe per year. The potential amount of biogas that can be obtained from animal breeding facilities amounts to 160,000 tons of oil equivalent per year. The launch of 10 biogas installations is planned in Belarus by 2010. At present, there are 3 biogas installations in operation in the Republic of Belarus (in the towns of Zaslavl, Brest and Homel). Introduction of biogas installations requires that numerous obstacles be overcome. One of them is the lack of interest by farms which are still offered electricity at preferential prices. The plans, however, assume that private foreign investors will be acquired to build, every year, 8–10 installations for recovering and using biogas produced in the course of the animal breeding process. The potential energy included in municipal waste created in the territory of Belarus equals 470,000 tons of oil equivalent. The effectiveness of processing organic waste to produce gas will equal no more than 20–25%, which equals 100–120 thousand tons of oils equivalent. The considerable amount of waste collected over the years at landfill sites is also to be taken into consideration. Belarus has some experience in implementing projects concerned with the use of landfill gas – a project of this type was carried out, with the use of private investor

funds, at the "Trostynets" landfill site, and the system's power rating equaled 3.0 MW.

The economically effective potential of wood and wood waste used for heat and electricity production equals 2.24 Mtoe in 2010 and 3.10 Mtoe in 2012. Switching to local fuel types is carried out under centralized state scrutiny, which, on the one hand, offers incentives for using wood fuels to provide heat energy, but on the other hand, it has to be borne in mind that enterprises are mainly concerned with the amount of wood they burn, and not the project's economic feasibility. It is often the case that production of heat at local heat plants with the use of wood is 2–2.5 times more expensive than in the case of natural gas. The above is caused mainly by a deficient wood fuel collection and processing system, low level of automatization, and the fact that in many instances unsuitable types of wood are used. The problem could be solved by replacing the mechanisms used for stimulating the use of wood fuels with those based on the free market principles. The development of and support for small private businesses to boost their share in preparing wood for energy production purposes is considered a prospective solution. The mini heat plants in Osipovichi and Vileyka have been adapted to use wood as part of a few pilot programs. Approximately 50 other boiler plants have been constructed or modernized.

The economic use of energy provided by small rivers equals to 0,11–0,15 Mtoe per year. The potential power rating of all Belarus' rivers is 850 MW, with the use of 220 MW out of that amount being economically feasible – this is the target figure that the total power rating of all small water power plants in Belarus is expected to reach by 2020. Currently, the Belarusian power grid uses water plants with the installed power of approximately 20 MW. About 4% of the total water energy potential has so far been used in the Republic of Belarus. Within the next few years the following are to be commissioned: Grodno Power Plant with the power rating of 17 MW on the river of Neman, Polotsk Power Plant (23 MW) on the river of Dvina, a Dnieper power plant (5 MW) and mini power plants on the rivers of Moroch, Sluch, Rich, Servech, Isloch and other small rivers.

According to relevant analyses, it is possible to construct hundreds of water power plants in Belarus. At present, construction of the first geothermal station is planned in the vicinity of Brest, in the "Beriestye" heat plant. The plans assume that water with the temperature of 25–30 degrees centigrade will be pumped to heat the greenhouses of a state owned agricultural enterprise.

In Belarus there are isolated cases in which renewable energy sources are used to cater for private needs – construction of eco-homes (the "Eco Home" Social Organization, Minsk City Branch of the International Social Ecologist Organization); installation of a rotor wind turbine to provide energy for an office ("Mohylev Technopark" Joint Stock Company).

In 2008 the first two biogas-powered plants were commissioned in Belarus – at the "Belorussky" fowl breeding farm in the town of Zaslavl (340 kW – stage I) and in the "Zapadny" selection and hybrid center in the Brest Region (520 kW). Construction work at the biogas complex in the "Homel Fowl Farm" Inc. is at its final stage at the moment. Construction of biogas complexes is also under way at animal breeding farms in Lan-Nesvyezh and Snow. In the "Rassvet" kolkhoz in the Kirov Region a biogas production system with the power rating of 3 MW is being prepared.

Conclusions / Prospects

Development of the renewable energy sector is of particular importance for the Republic of Belarus. It is the only means of increasing the country's actual independence, primarily from Russia. As discussing independence of a country that relies on "gas injections" is inappropriate, development of the renewable energy sector will positively impact both the economic and environmental situation of Belarus. The potential that Belarus has in the field of renewable energy sources is immense. Some research has already been conducted, and the authorities, as well as local government and coordinating entities are receiving the information. The market is in the "starting blocks". It is high time that leaders appeared, who will guide the development of the renewable and alternative energy sector.

Text 11.

Alternatives to Using Eco-fuels Already Being Tested Successfully

Drivers maybe unaware that, in buying diesel, they are purchasing a biofuel; the only giveaway is the green mark on the pump. The latest development will soon be available countrywide, with supplies being distributed from Belarus' only such plant, which makes the fuel from rape seed oil. Grodno Azot JSC made its first batch in early August and is now at maximum capacity – 7 tonnes a day. The company's Chief Engineer, Andrey Sirotin, holds up a bottle of fragrant brown liquid and explains, "To make

biofuel, we have to mix the oil with methanol; since we are the only producers, we have a unique market niche."Alternative fuels began appearing some time ago, with scientists all over the world working hard to fund substitutes for refined oil products.

In Italy, they mash grape-stones to create oil, but rape seed is the most suitable product for Belarus. "We can generate three tonnes of seed from a single hectare – enough to make a tonne of oil. After mixing with methanol, we receive one tonne of fuel: rane share comprises just 5 percent of the total, meeting European standards," stresses Georgy Ushkevich, Deputy Head of Perspective Development and Investments at Belneftekhim. He has high hopes for the project, which is now being tested by the Minsk Motor Plant. The new diesel is less toxic and smoky and provides better lubrication than ordinary diesel fuel. Diesel comprising 30 percent biofuel is now being tested and Grodno Azot's General Director, Alexander Radevich, is convinced that interest will continue to grow, "Initially, our plant is producing 2,000 tonnes a year. Within 12 months, we plan to install new equipment, enabling us to manufacture 60,000 tonnes. We need double this amount, in fact."

Belneftekhim has announced plans to expand biofuel production to Mogilev's Khimvolokno site.

Text 12.

Storing Wind Power as Ice?

Of the total amount of electricity generated by all sources, about 75% is used by buildings, a major fraction of which is consumed by air conditioners. With the demand of renewable energy increasing with every passing day, inventors are trying to find the best possible means to store the generated energy during the best time, to provide power when the generators aren't getting the resources they need. It is a natural phenomenon that the wind blows stronger at night than in the day. We don't need that extra energy during nighttime. We can store this energy and use it during daytime when the load is too much on the grid.

When we utilize alternative sources of energy, how to store the energy poses a big problem. Scientists often create giant sized batteries or compressed air and hydroelectric storage. But now a company, **Calmac** Booth is thinking of storing extra power in ice!

Air conditioning in the summer consumes the lion's share of a building's energy cost. Calmac Booth is manufacturing a hybrid cooling system. This system exploits an ice bank thermal energy

storage tank known as IceBank. IceBank makes and stores ice for use in air conditioning systems when the wind is blowing a bit faster or the sun isn't shining, that is, at night.

Heavily insulated polyethylene is used to manufacture the IceBank tanks. They also contain a spiral-wound, polyethylene-tube heat exchanger surrounded with water. The tanks are available in a variety of sizes. According to one's need it is available from 45 to over 500 ton-hours. When the charging cycle is going on, a solution containing 25% ethylene or propylene glycol is cooled by a chiller. In the next step this solution is circulated through the heat exchanger inside the IceBank tank. It has to be noted that the ethylene-based or propylene-based is an industrial coolant. These coolants are particularly devised for low viscosity and superior heat-transfer properties.

The unique property of the IcaBank is that the ice is built uniformly throughout the tank. Charging cycle of an IceBank tank takes about 6 to 12 hours. This device can also be utilized in conjunction with a solar panel array.

During summer time the entire system tries to survive during peak hours. IceBank simply prepares ice at night, when electricity is cheaper and it is cooler. During afternoon, this stored energy can be consumed by running air conditioning. At that time it is hot and electricity is in short supply. IceBank can help in reducing the load on the grids during peak hours. According to the company reducing electricity demand for cooling can cut energy costs by 20–40 percent. That reduction also translates into fewer emissions from power plants.

This system can be applicable to those buildings too which are without on-site renewable energy power generation. Ice can be prepared during night i.e. off-peak time. During off-peak, electricity is cheaper and cleaner baseload generation can be used. Calmac explains that for every kilowatt-hour of energy that is shifted from on-peak usage to off-peak, there is a decrease in the source fuel needed to generate it. This reduction can be between 8 and 30%.

Text 13.

Tokamak

A tokamak is a machine producing a toroidal magnetic field for confining a plasma. It is one of several types of magnetic confinement devices, and it is one of the most-researched candidates for producing controlled thermonuclear fusion power.

The term *tokamak* is a transliteration of the Russian word "токамак" which itself is an acronym made from the Russian words: "тороидальная камера с магнитными катушками" – toroidal chamber with magnetic coils (possibly tochamac). An alternative, possibly older, abbreviation exists, meaning toroidal chamber with axial magnetic field. It was invented in the 1950s by Soviet physicists Igor Yevgenyevich Tamm and Andrei Sakharov.

The tokamak is characterized by azimuthal (rotational) symmetry and the use of the plasma-borne electric current to generate the helical component of the magnetic field necessary for stable equilibrium. This can be contrasted to another toroidal magnetic confinement device, the stellarator, which has a discrete (e.g. fivefold) rotational symmetry and in which all of the confining magnetic fields are produced by external coils with a negligible electric current flowing through the plasma.

Although nuclear fusion research began soon after World War II, the programs were initially classified. It was not until after the 1955 United Nations International Conference on the Peaceful Uses of Atomic Energy in Geneva that programs were declassified and international scientific collaboration could take place.

Experimental research of tokamak systems started in 1956 in Kurchatov Institute Moscow by a group of Soviet scientists led by Lev Artsimovich. The group constructed the first tokamaks, the most successful of them being T-3 and its larger version T-4. T-4 was tested in 1968 in Novosibirsk, conducting the first ever quasi stationary thermonuclear fusion reaction.

In 1968, at the third IAEA International Conference on Plasma Physics and Controlled Nuclear Fusion Research at Novosibirsk, Soviet scientists announced that they had achieved electron temperatures of over 1000 eV in a tokamak device. This stunned British and American scientists, who were far away from reaching that benchmark. They remained suspicious until tests were done with laser scattering a few years later, confirming the original temperature measurements.

In an operating fusion reactor, part of the energy generated will serve to maintain the plasma temperature as fresh deuterium and tritium are introduced. However, in the startup of a reactor, either initially or after a temporary shutdown, the plasma will have to be heated to its operating temperature of greater than 10 keV (over 100 million degrees Celsius). In current tokamak (and other) magnetic fusion experiments, insufficient fusion energy is produced to maintain the plasma temperature.

A tokamak contains reacting plasma which spirals around the reactor. Since a high number of reactions per second is required to sustain the reaction in a tokamak, high energy neutrons are released quickly in large amounts. These neutrons are no longer held in the stream of plasma by the toroidal magnets and continue until stopped by the inside wall of the tokamak. This is a large advantage of tokamak reactors since these are very high energy neutrons; the freed neutrons provide a simple way to extract heat from the plasma stream. The inside wall of the tokamak must be cooled because these neutrons are at a high enough temperature to melt the walls of the reactor. A cryogenic system is used to cool the magnets and inside wall of the reactor. Mostly liquid helium and liquid nitrogen are used as refrigerants. Ceramic plates specifically designed to withstand hot temperatures are also placed on the inside reactor wall to protect the magnets and reactor.

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A a

ability *n* – способность, возможность
absorb *v* – впитывать; абсорбировать; поглощать
absorption *n* – впитывание; абсорбция; поглощение
abundant *adj* – обильный, богатый, изобилующий
account *v* – 1) (~for) входить во (что-л.) в размере, количестве; составлять часть от общего количества (чего-л.); 2) (~for) объяснять (что-л.); быть причиной (чему-л.), вызывать (что-л.)
acetic acid *n* – уксусная кислота
achieve *v* – достигать, добиваться
adaptable *adj* – легко приспосабливаемый
additive *n* – 1) добавка; присадка 2) примесь
adjustment *n* – 1) регулирование; согласование; 2) регулировка, подгонка, наладка, настройка; 3) приспосабливание, адаптация
advancement *n* – продвижение, прогресс
airfoil *n* – 1) аэродинамическая поверхность; крыло; профиль крыла; 2) деталь с аэродинамическим профилем
alpha radiation *n* – альфа-излучение
altitude *n* – 1) высота; высота над уровнем моря; 2) высота, размер по вертикали
ammonia *n* – аммиак
anthracite *n* – антрацит
appliance *n* – 1) оборудование; прибор; инструмент; 2) *pl.* бытовое оборудование, бытовые приборы, бытовая техника
application *n* – применение, использование, употребление
approximate *adj* – 1) близкий, находящийся близко; 2) приблизительный, примерный; 3) сходный, близкий
approximate *v* – 1) приближаться; почти соответствовать (чему-л.); 2) быть приблизительно верным, приблизительно равняться
approximately *adv* – приблизительно, близко, около почти, приближенно
ash *n* – зола, пепел; шлак
attach *v* – присоединять
available *adj* – доступный; имеющийся в распоряжении
axis *n* – ось, вал

B b

bake *v* – 1) обжигать; 2) затвердевать
barge *n* – баржа
barrel *n* – баррель *(мера жидких, сыпучих и некоторых твердых материалов)*
beta radiation – бета-излучение
biodegradable *adj* – поддающийся биологическому разложению; распадающийся до простых веществ под действием бактерий
biomass *n* – биомасса
bituminous *adj* – битумный
blend *v* – смешивать

blend *n* – смесь
bonfire *n* – костер
branch *n* – 1) ветвь, ветка *(растений)* 2) отрасль, подразделение
bundle *n* – связка; пучок
butane *n* – бутан
byproduct *n* – побочный продукт

C c

calorific *adj* – тепловой, термический
campfire *n* – бивачный костер
capacity *n* – 1) вместимость, объем; 2) способность *(что-л. делать)*; 3) возможность; 4) мощность, нагрузка; производительность
capitalize *v* – извлекать выгоду из чего-л., использовать для собственной выгоды
capture *v* – 1) завладеть, захватить, увлечь; 2) поглощать, захватывать
carbon *n* – углерод; уголь
carbon dioxide *n* – углекислота; углекислый газ
catalyst *n* – катализатор
cause *v* – 1) послужить причиной, поводом (для чего-л.); мотивировать (что-л.), вызывать; 2) заставлять; добиваться
causticity *n* – едкость, жгучесть; способность разрушать органические ткани
cell phone *n* – сотовый телефон
charcoal *n* – древесный уголь
charge *v* – 1) заряжать *(аккумулятор)*; 2) нагружать; загружать (*уголь в топку*); 3) насыщать, наполнять; 4) заполнять, наполнять, пронизывать
chiller *n* – холодильник, холодильная установка
cluster *n* – 1) скопление, концентрация; 2) группа
coal deposit *n* – угольное месторождение
co-firing *n* – совместное сжигание
co-generation *n* – комбинированное производство тепловой и электрической энергии
coke *n* – кокс
collide *v* – 1) сталкиваться; соударяться; 2) сталкиваться, приходить в противоречие; конфликтовать
combine *v* – 1) объединять, сочетать; 2) соединяться, объединяться; 3) компоновать, соединять
combustible *adj* – воспламеняемый, горючий
combustion *n* – горение, возгорание, сжигание
comparable *adj* – 1) заслуживающий сравнения; 2) сопоставимый, соизмеримый
compose *v* – составлять
compress *v* – 1) сдавливать; 2) сжимать; 3) сплющивать; прессовать
concern *v* – затрагивать, касаться, иметь отношение
concern *n* – проблема; вопрос, требующий решения; забота
concurrent *adj* – 1) совпадающий; 2) сопутствующий; параллельный; 3) действующий взаимозависимо
conduct *v* – проводить
conductor *n* – проводник
consecutive *adj* – 1) последовательный; (непрерывно) следующий друг за другом; 2) логичный, упорядоченный

consider *v* – 1) рассматривать, обсуждать; 2) взвешивать, обдумывать, продумывать; 3) думать, полагать, считать; 4) принимать во внимание, учитывать

considerably *adv* – значительно, много

consistent *adj* – 1) последовательный; 2) постоянный

consistently *adv* – 1) в соответствии с, согласно; 2) последовательно, согласованно; 3) единообразно, равным образом

construct *v* – строить, сооружать; воздвигать; конструировать

consumer *n* – потребитель

consumption *n* – потребление

contact *n* – 1) соприкосновение; 2) связь, контакт

contain *v* – содержать в себе, включать, иметь в своем составе; вмещать

containment *n* – 1) защитная оболочка *(ядерного реактора)*; 2) сдерживание; 3) герметичность

content *n* – содержание

contribute *v* – содействовать, способствовать, вносить вклад

control rod – управляющий стержень

convection *n* – конвекция

convenience *n* – 1) удобство, удобность; 2) благоприятная возможность; 3) приспособление, механизм, устройство

conventional *adj* – обычный, обыкновенный, традиционный; общепринятый

conversion *n* – 1) превращение, преобразование, обращение; 2) конверсия, реструктуризация 3) химическое превращение, реакция

convert *v* – преобразовывать; превращать, трансформировать

conveyor belt *n* – конвейерная лента; лента транспортера

coolant *n* – охлаждающий агент, охлаждающее вещество, охлаждающая жидкость, охладитель (агент), теплоноситель (ядерного реактора), хладагент

cosmic *adj* – 1) космический; 2) большой, грандиозный; колоссальный; мировой

counterpart *n* – 1) дубликат, копия; 2) аналог

cover *v* – 1) накрывать, закрывать, покрывать; 2) защищать, ограждать, укрывать

crayon *n* – карандаш

create *v* – порождать, производить; создавать, творить

critical *adj* – решающий, критический

crude oil *n* – сырая, неочищенная нефть

crumbly *adj* – крошащийся, рассыпчатый, хрупкий, ломкий, рыхлый

cryogenic *adj* – криогенный

current *n* – 1) струя; поток, течение; 2) течение *(времени)*; ход *(событий)*; 3) ток

current *adj* – текущий, данный, современный

D d

dam *n* – плотина

decaying *adj* – разлагающийся, гниющий

define *v* – 1) определять, давать

определение; 2) характеризовать; определять, устанавливать

dehumidification *n* – осушение *(воздуха, газа)*; удаление избытка влаги; высушивание

demand *v* – 1) требовать; 2) нуждаться

deodorant *n* – дезодорант

depend *v* – зависеть

deposit *n* – 1) отложение; 2) осадок; 3) месторождение, залежь *(полезных ископаемых)*

deposit *v* – отлагаться, осаждаться

depth *n* – глубина

derive *v* – 1) получать, извлекать; 2) выводить, получать; 3) устанавливать происхождение

derrick *n* – деррик-кран

desiccan *n* – высушивающее вещество, дессикант, сиккатив, осушитель

device *n* – устройство, приспособление; механизм; аппарат, машина, прибор

diatoms *n* – диатомовые водоросли, диатомы

diesel*n* – дизель, дизельный двигатель

dime *n* – монета в 10 центов

dinosaur *n* – динозавр

disconnect *v* – разъединять, разделять, разобщать, отсоединять; расцеплять

dishwashing liquid – жидкое моющее средство

disintegrate *v* – разделять на составные элементы, раскладывать на составляющие, дезинтегрировать

disruption *n* – 1) разрушение; 2) разрыв; подрыв; 3) нарушение

distribute *v* – 1) распределять, раздавать; 2) распространять

doorstep *n* – порог

draft *n* – тяга; сквозняк

dramatic *adj* – резкий, существенный *(об изменениях)*

dramatically *adv* – значительно, сильно

drilling *n* – 1) сверление; 2) бурение

dry *v* – сушить

dump *n* – свалка

dung cake – брикет органического удобрения

E e

ecosystem *n* – экосистема

electrical grid – электрическая сеть

elevation *n* – 1) высота *(над уровнем моря)*; 2) повышение, поднятие; 3) высотная отметка; 4) превышение; 5) поднятие, подъем

emission *n* – выделение, распространение *(тепла, света, запаха)*; выброс

emit *v* – испускать, выделять *(свет, тепло)*; выбрасывать, извергать *(пепел, дым)*

engine torque – крутящий момент двигателя

enrichment *n* – обогащение

ensure *v* – гарантировать, обеспечивать

enterprise *n* – предприятие; фирма; компания

environment *n* – окружающая среда

equation E = mc^2 – формула закона взаимосвязи массы

и энергии (*энергия = масса × × квадрат скорости света*)

equipment *n* – оборудование

escape *v* – просачиваться; улетучиваться

essentially *adv* – 1) по существу; по существу дела; 2) существенно, существенным образом; 3) в высшей степени; чрезвычайно

establishment *n* – 1) учреждение; предприятие; 2) создание, образование

ethane *n* – этан

ethylene *n* – этилен

evaporate *v* – испарять; испаряться, улетучиваться

evaporating – выпаривание; испарение

exhaust *n* – 1) выпуск, выхлоп *(процесс выхода газа в окружающую среду);* 2) выхлопные газы

exhaustion *n* – истощение; исчерпание

expand *v* – развивать, расширять

expensive *adj* – дорогой

expertise *n* – 1) экспертиза; экспертная оценка; 2) человеческий опыт, знание дела; квалификация, компетентность; 3) искусство, мастерство, умение

explode *v* – взрывать

exploitation *n* – использование, употребление, эксплуатация

explore *v* – 1) исследовать, рассматривать, изучать, анализировать; пробовать, экспериментировать; 2) выяснять, устанавливать, узнавать, обнаруживать

extensive *adj* – 1) пространственный, обладающий протяженностью, громадный, большой; 2) всесторонний, далеко идущий, исчерпывающий

extract *v* – получать, извлекать

extremely *adv* – чрезвычайно, крайне, в высшей степени; очень

eyesore – 1) что-л. противное, оскорбительное *(для глаза);* 2) бельмо на глазу

F f

feasible *adj* – 1) возможный; выполнимый; осуществимый; 2) допустимый; подходящий

feedstock – исходное сырьё

field pole – полюс возбуждения *(электрического двигателя или генератора)*

fireplace *n* – камин, очаг

fission *n* – деление; расщепление

flammability *n* – воспламеняемость

flexibility *n* – эластичность, гибкость, упругость

flexible *adj* – гибкий; гнущийся; мягкий, эластичный

flicker *v* – мелькнуть, промелькнуть; мгновенно пронестись

focus (on) *v* – сосредоточивать, обращать *(внимание и т.п.)*; сосредоточиваться; концентрироваться

forefront *n* – передний план; важнейшее место

formaldehyde *n* – формальдегид

fossil fuel *n* – ископаемое топливо

freely *adv* – свободно; легко

freestanding – автономный, отдельностоящий

freewheeling – свободно вращающийся
fryer *n* – 1) обжарочный аппарат; обжарочная ванна; 2) плита; 3) сковорода
fuel cell *n* – 1) топливный элемент; 2) топливная батарея
fueling – заправка топливом; обеспечение топливом
fuelwood *n* – дрова, древесное топливо
fulfil *v* – 1) выполнять; делать, исполнять, осуществлять, совершать; 2) завершать, заканчивать, оканчивать
furnace *n* – горн; очаг; печь
fusion *n* – 1) плавка, плавление; 2) расплавленная масса, расплав

G g

gamma radiation – гамма-излучение
generate *v* – 1) вызывать, порождать; 2) производить; генерировать, делать
generation *n* – 1) генерация, генерирование; порождение; 2) образование; формирование; создание; 3) поколение; 4) производство; выработка; получение
geothermal *adj* – геотермальный
global warming – глобальное потепление
gravity *n* – сила тяжести, гравитация
guard *v* – охранять

H h

habitable *adj* – 1) заселенный, населенный, обитаемый; 2) годный для жилья, удобный для жилья, жилой
harmful *adj* – вредный, пагубный, губительный
harness *v* – использовать
heart valve – сердечный клапан
hearth *n* – 1) дом, домашний очаг; 2) камин
heat exchanger – теплообменник
heater *n* – печь; обогреватель; нагревательный прибор
heating value – 1) теплопроводность; теплотворная способность; 2) теплота сгорания *(топлива)*
hit *v* – ударять(ся), сталкивать(ся)
house *v* – вмещать, содержать
households *n* – хозяйство
humidity *n* – сырость, влажность
hydrocarbon *n* – углеводород
hydropower *n* – гидроэнергетика

I i

ignited – запаленный, воспламененный
ignition *n* – 1) зажигание, воспламенение; вспышка; запал; 2) прокаливание
illuminant *n* – 1) источник света; 2) светильник, осветительный прибор; 3) освещающий; осветительный
incineration *n* – сжигание
include *v* – 1) заключать, включать в себя, содержать в себе; 2) включать, присоединять
incomplete *adj* – 1) недостаточный, неполный; 2) недоконченный, незавершенный, незаконченный; 3) дефектный, несовершенный; уязвимый
increase *v* – увеличивать
inexhaustible *adj* – неистощи-

мый, нескончаемый, неисчерпаемый
infancy *n* – ранняя стадия развития; период становления; начальная стадия процесса
influence *v* – влиять
infrared heating – нагрев инфракрасным излучением
initially *adv* – в начальной стадии, в начале
injustice *n* – несправедливость
innovative *adj* – новаторский, передовой, рационализаторский
installation *n* – установка; сборка; инсталляция
instant *n* – мгновение, миг, момент
integrate *v* – совмещать; объединять; интегрировать
intermediate *adj* – промежуточный, переходный
invoke *v* – осуществлять, способствовать осуществлению
involve *v* – включать в себя, содержать
iron ore *n* – железная руда
irrigation *n* – орошение
isotope *n* – изотоп

K k

kernel *n* – ядро; сердцевина
kind *n* – вид, сорт

L l

leakage *n* – протечка, течь, просачивание; утечка
lethal *adj* – смертельный; летальный; смертоносный
lift *v* – поднимать, повышать
lignite *n* – лигнит, бурый уголь
limestone *n* – известняк
liquefy *v* – плавить, растапливать; сжижать
liquid *n* – жидкость
load *n* – груз; загруженность; нагрузка
longitudinal *adj* – продольный
loops *n* – петля; змеевик
low-impact *adj* – низкого воздействия
lubricating *adj* – смазывающий

M m

maintain *v* – 1) обслуживать; поддерживать; содержать в исправности; 2) эксплуатировать
manufacture *n* – производить, изготавливать, выпускать
masonry *n* – каменная или кирпичная кладка
measurement *n* – измерение
melt *v* – плавить; таять
methanol *n* – 1) метанол; 2) топливо на основе метилового спирта
mine *n* – 1) копь; шахта; горная выработка; 2) залежь, месторождение, рудник; *v* – 3) производить горные работы, добывать руду; разрабатывать месторождение
mitigation *n* – ослабление; смягчение; подавление
modification *n* – изменение; видоизменение; модификация, трансформация
moisture *n* – влажность, сырость; влага, мокрота
molecule *n* – молекула
motion *n* – движение; перемещение; ход
multifunctional *adj* – многофункциональный

multitude *n* – множество; большое число; масса

N n

natural gas *n* – природный газ
neutron *n* – нейтрон
nitrogen oxides *n* – оксиды азота
non-replenishable *adj* – невозобновляемый
nuclear *adj* – ядерный; относящийся к атомному ядру; относящийся к ядерной энергии
nucleus *n* – атомное ядро

O o

object *n* – 1) предмет; вещь; 2) объект, предмет; 3) цель
occupy *v* – занимать
occur *v* – 1) встречаться, попадаться; 2) происходить, случаться, иметь место; 3) залегать (*о месторождении*)
oil *n* – масло, нефть
operational performance – эксплуатационная характеристика
option *n* – выбор, альтернатива, вариант
ounce *n* – унция
overall *adj* – полный, общий, от начала до конца
overcast *adj* – затянутый облаками; хмурый
ozone depletion – истощение озонового слоя

P p

paddle wheel *n* – гребное колесо
particle *n* – частица; крупица
particulates *n* – твердые частицы в отработавших, выхлопных газах
pellet *n* – топливная таблетка (*для ядерного реактора*)
penetrate *v* – входить, проникать внутрь; проходить сквозь, пронизывать
penstock *n* – 1) шлюз, шлюзный затвор; 2) напорный трубопровод; турбинный водовод
per capita – на человека, на душу населения
personnel *n* – коллектив; персонал; личный состав; штат
petroleum *n* – нефть
photocell *n* – фотоэлемент
picosecond *n* – пикосекунда
pipe *n* – труба
pipeline *n* – трубопровод; нефтепровод
plastics *n* – пластмасса, пластик
platinum catalyst – платиновый катализатор
plug *v* – подключать, проводить
plutonium *n* – плутоний
portable *adj* – портативный, переносный, передвижной, транспортабельный
potassium *n* – калий
powder-coating *n* – порошковое покрытие; покрытие, полученное напылением порошковых материалов
power *n* – 1) мощность; 2) энергия; 3) источник энергии
power plant *n* – 1) энергетическая установка, энергоустановка 2) электрическая станция, электростанция, ЭС
praise *v* – хвалить; восхвалять; превозносить, прославлять
preserve *v* – сохранять, сбе-

регать; оберегать, охранять, защищать

pressure *n* – давление

pressurized *adj* – 1) прессованный, запрессованный; 2) под давлением, находящийся под давлением; 3) герметичный

primordial *adj* – первичный, начальный

principle *n* – правило; принцип

prior to *prep* – до, перед

private *adj* – частный

process *n* – 1) процесс; 2) технологический процесс; 3) прием, способ

propane *n* – пропан

propeller-type blades – лопасти пропеллерного типа

properly *adv* – должным образом; как следует; правильно

proton *n* – протон

public utility company – коммунальная компания, компания коммунального хозяйства [коммунального обслуживания] *(компания, занимающаяся снабжением газом, электроэнергией, водой или предоставлением других коммунальных услуг)*

purify *v* – очищать

purpose *n* – цель, намерение; замысел, стремление

Q q

qualification *n* – квалификация; подготовленность, пригодность; навык; степень квалифицированности; профессионализм

quality *n* – качество

quantity *n* – количество

R r

radiant *adj* – лучистый, лучевой

range *v* – варьироваться, колебаться в пределах

rarefaction *n* – 1) разрежение; разжижение; 2) разреженность

raw material – необработанный материал; сырье

reactor core – активная зона ядерного реактора

reciprocating *adj* – качающийся; поршневой; совершающий возвратно-поступательное движение

recognize *v* – распознавать; опознавать; различать

reconfigure *v* – изменять конфигурацию, реконфигурировать

recycling industry – перерабатывающая промышленность

reduce *v* – ослаблять, понижать, сокращать, уменьшать

refinery *n* – нефтеперегонный завод

refractory *adj* – 1) огнеупор, огнеупорный материал; 2) жаростойкий; тугоплавкий; 3) плохо поддающийся переработке

refrigerant *n* – охлаждающее вещество, охладитель

refuel *v* – дозаправиться, пополнить запасы топлива

regard *v* – 1) расценивать, рассматривать; считать; 2) относиться; 3) касаться *(кого-л. / чего-л.)*, иметь отношение *(к кому-л. / чему-л.)*; 4) при-

нимать во внимание, считаться *(с кем-л. / чем-л.)*

release *v* – 1) освобождать; отпускать; 2) выбрасывать; выпускать; 3) выделять (энергию, теплоту)

relevant *adj* – релевантный; значимый; существенный; важный

reliable *adj* – надежный; верный, испытанный

rely on *v* – надеяться, полагаться

remain *v* – оставаться; находиться

remains *n* – *pl.* 1) руины, развалины; 2) остатки

renewable source – возобновляемый источник

repair *v* – ремонтировать

requirement *n* – 1) требование; необходимое условие; 2) надобность, необходимость, нужда, потребность

research department – отдел исследований

resemble *v* – походить, иметь сходство

reserve *n* – запас, резерв

reservoir *n* – резервуар; бассейн; водохранилище

residential *adj* – 1) жилой *(о районе города);* 2) связанный с местом жительства

residue *n* – остатки, отходы

resurgence *n* – возрождение; восстановление

reverse *v* – менять местами

rod *n* – стержень

rot *v* – 1) гнить; 2) разлагать(ся)

rotate *v* – вращать(ся); поворачивать(ся)

rotor *n* – 1) ротор; 2) рабочее колесо (*турбины, насоса*)

run out *v* – кончаться, иссякать

rush *v* – бросаться, мчаться, нестись, устремляться

S s

sail *v* – плавать под парусами

sample *n* – 1) образец; экземпляр; 2) проба

sandstone *n* – песчаник

sawdust *n* – древесные опилки

sawmill *n* – лесопилка; лесопильный завод

scatter *v* – 1) разбрасывать, рассыпать, раскидывать; 2) размещать *(в разных местах)* 3) разгонять, рассеивать

sedimentary rock – осадочная горная порода

selectively *adv* – выборочно, по выбору, избирательно

self ignition *n* – 1) самовозгорание; 2) самовоспламенение

separately *adv* – отдельно, поодиночке, порознь, раздельно

sequentially *adv* – 1) последовательно, один за другим; 2) последовательно, логически

service *n* – 1) работа; сфера деятельности; 2) эксплуатация; 3) обслуживание; 4) услуги, сервис

setting *n* – установка

shaft *n* – вал; ось; стержень

ship *v* – перевозить *(груз, товар)*, отправлять *(различными видами транспорта)*

significant *adj* – значительный, важный, существенный

silt *n* – ил; наносы; осадок

sink *n* – слив; сток

sluice *v* – 1) оборудовать шлюзами; шлюзовать; 2) спускать, выпускать воду через шлюз; вытекать, литься через шлюз
smelly *adj* – вонючий, зловонный
smelt *v* – подвергать плавке; расплавлять, выплавлять
soapstone *n* – мыльный камень, стеатит
sodium *n* – натрий
solar energy – солнечная энергия
span *v* – 1) охватывать, простираться, распространяться; 2) перекрывать
spew *v* – 1) извергаться, бить ключом, фонтанировать; 2) выдавливать, выпрессовывать
spin *v* – крутить, вертеть
split *v* – 1) раскалывать; расщеплять, разбивать на части; 2) разбивать; разрушать; 3) разделять, делить на части; распределять
spontaneous *adj* – самопроизвольный, спонтанный, беспорядочный
stator *n* – статор а) неподвижная часть электрических и гидравлических машин роторного типа; б) неподвижная часть конденсатора переменной емкости
steam *n* – пар
steam reforming – образование пара
store *v* – 1) запасать; накапливать 2) хранить; складировать
stove *n* – плита
strata *n* – *pl. от stratum* 1) слои; пласты 2) напластование; отложение пород
stretched *adj* – натянутый
structure *n* – строение, структура; конструкция, устройство
subbituminous *adj* – слабобитуминозный
subcritical *adj* – докритический, субкритический
subject (to) *v* – 1) подчинять, покорять; 2) подвергать *(воздействию, влиянию и т.п.)*
substance *n* – вещество
sulfur *n* – сера
sulfur dioxide *n* – диоксид серы, сернистый ангидрид
supercritical *adj* – закритический, сверхкритический, надкритический
supplemental *adj* – дополняющий, дополнительный
surface mining – 1) открытые горные работы; 2) разработка открытым способом
swampy *adj* – болотистый, заболоченный, топкий
synthetic fiber – синтетическое химическое волокно
syrup *n* – сироп

T t

tailrace *n* – 1) нижняя вода; нижний бьеф; 2) отводящий канал *(водяной турбины)*
tanker *n* – 1) танкер, нефтеналивное судно; 2) бак, цистерна
tar *n* – смола; деготь; гудрон
tax break – налоговая льгота
technological advances – технический прогресс
technology *n* – 1) техника; технические и прикладные науки; 2) технология
tension *n* – напряжение, напряженное состояние

theorize *v* – 1) теоретизировать; 2) теоретически предсказывать
thermal *adj* – тепловой, термический
tidal *adj* – связанный с приливом и отливом; приливо-отливный; подверженный действию приливов
tiny *adj* – очень маленький, крошечный
tire *n* – шина, покрышка
tool *n* – инструмент
top layer – верхний слой, верхний уровень
torrent *n* – поток
total *adj* – весь, целый; общий, совокупный, суммарный
trail *v* – быть позади
transfer *v* – 1) переносить, перемещать; 2) перевозить, транспортировать, переправлять
transform *v* – 1) преобразовывать; 2) трансформировать; 3) обращать; превращать
transverse *adj* – пересекающийся, поперечный
trapping *n* – улавливание; захват, захватывание
treatment *n* – 1) *(технологическая)* обработка; 2) очистка
tremendous *adj* – огромный, гигантский, громадный
tremendously *adv* – очень, крайне, чрезвычайно
two-fold effect – двойной эффект

U u

ultimately *adv* – 1) в конечном счете, в конце концов; 2) окончательно
underground *adj*– подземный
underground mining – 1) подземные горные работы; 2) разработка подземным способом
uranium *n* – уран

V v

vapour *n* – пар; испарения
vehicular *adj* – транспортный
venting *n* – вентиляция; проветривание; выпуск воздуха; подвод воздуха
versatile *adj* – универсальный
vessel *n* – 1) сосуд; 2) корабль, судно
viable *adj* – жизнеспособный

W w

waste *n* – отходы
water intake – водозаборное устройство
well *n* – 1) колодец; 2) скважина; 3) водоём
wicket gate – поворотный затвор
wind farm – ветровая электростанция
windmill *n* – 1) ветряная мельница; 2) ветряк, ветродвигатель; ветроэнергетическая установка
wind tunneling – 1) туннельный эффект; туннельный переход; 2) туннелирование
wire *n* – проволока, провод

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